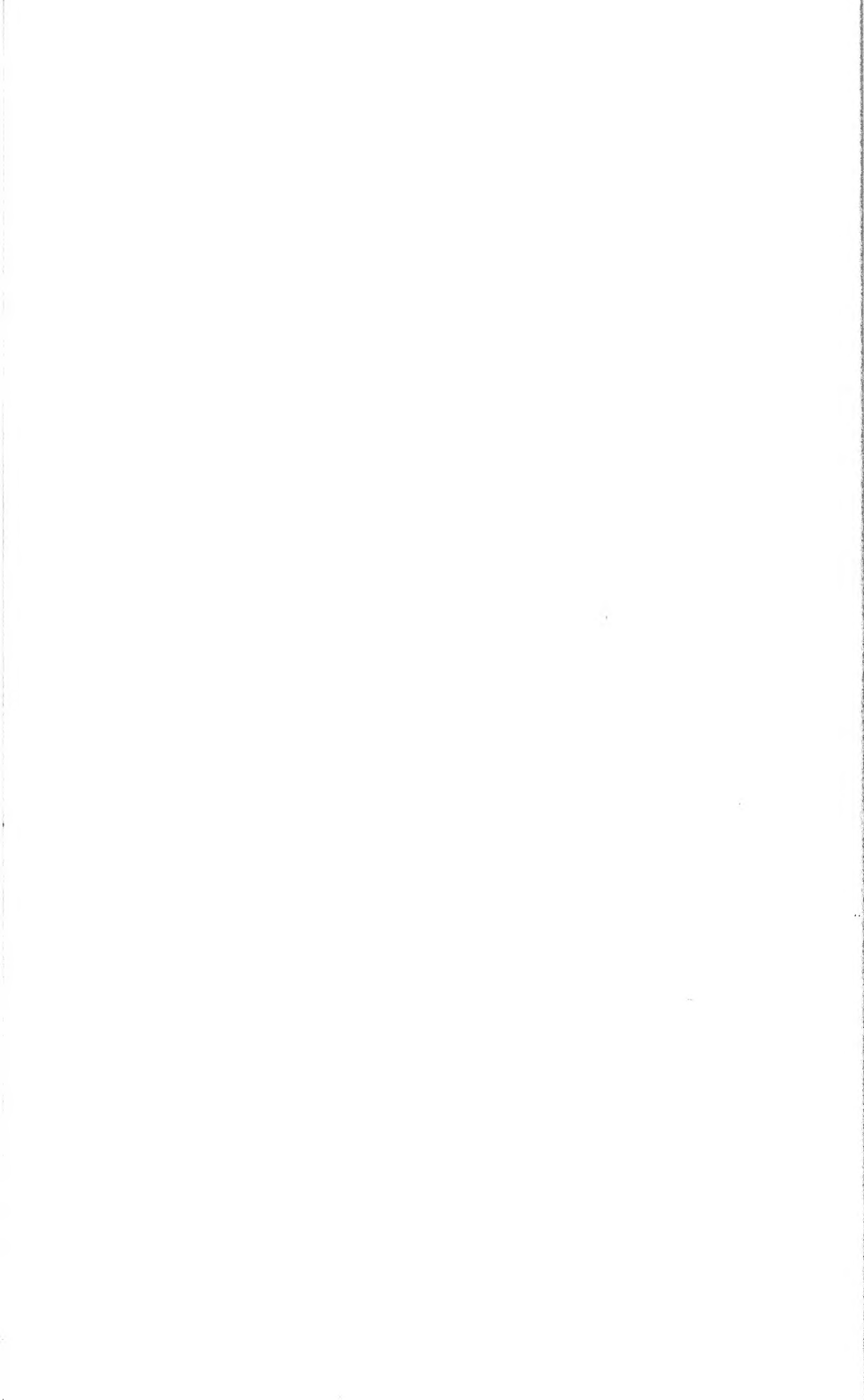
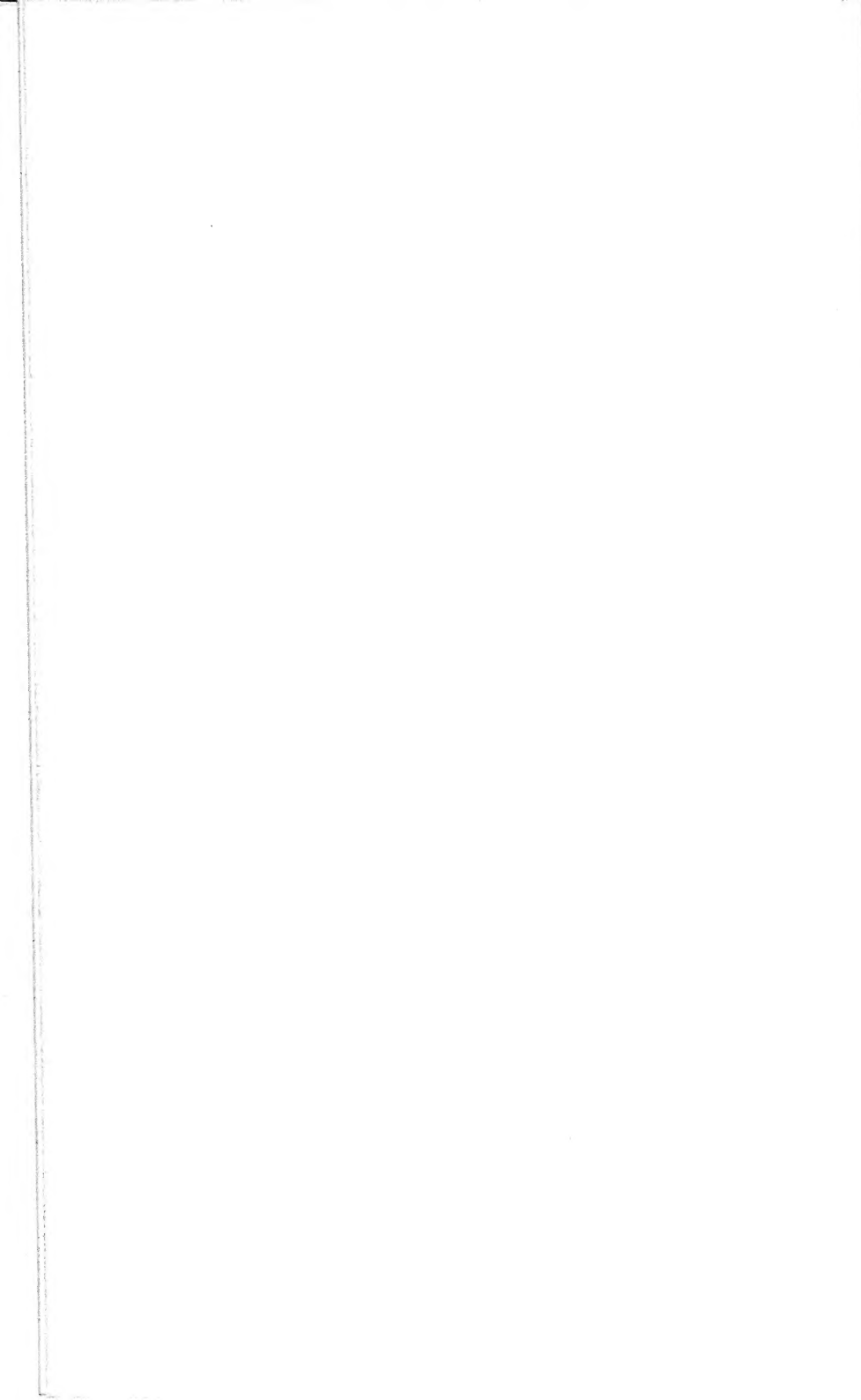


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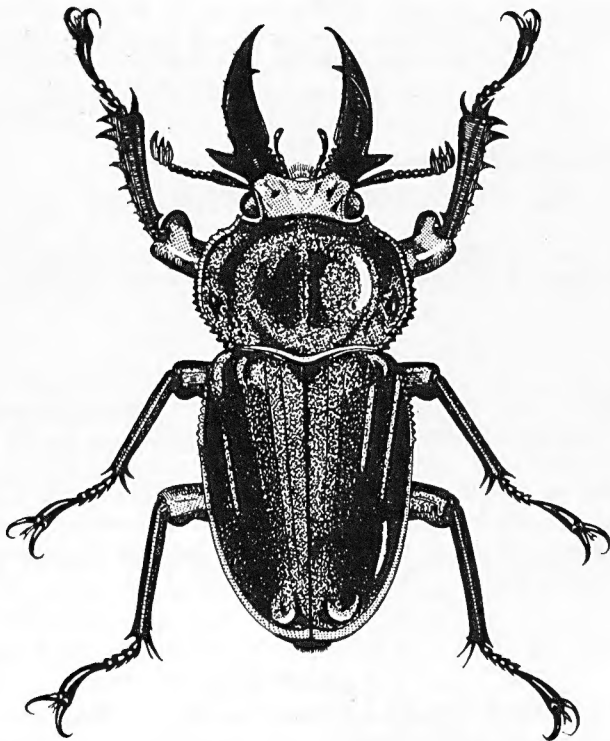




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COVER

Illustrated by B. L. Brunet

The large and beautiful stag beetle, *Phalacrognathus muelleri* Macleay (family Lucanidae), is one of Australia's most spectacular beetles. The dominant pigmentation is maroon and green with a brilliant mirror-like sheen. Large males can measure 60 mm or more in length. The species is found only in rain forest in north-eastern Queensland where the larvae feed in decaying logs. Adults fly at dusk and rarely venture beyond rain forest margins.

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NEW RECORDS OF LYCAENIDAE AND HESPERIIDAE (LEPIDOPTERA) FROM NORTHERN QUEENSLAND

By P. S. Valentine and S. J. Johnson

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and

P.O. Box 1085, Townsville, 4810

Abstract

Distribution extensions for eight species of HesperIIDae and seven species of LycaenIDae are given. *Acrodipsas brisbanensis* (Miskin) is recorded from northern Queensland for the first time.

Introduction

The following records provide some notable range extensions for several species of LycaenIDae and HesperIIDae. Of particular interest are the first record of *Acrodipsas brisbanensis* (Miskin) from northern Queensland and a new location for *Zetona delospila* (Waterhouse).

HESPERIIDAE

Euschemon rafflesia alba Mabille. This species occurs commonly at the southern extremity of the Paluma Range 16 km south-west of Bluewater, and 40 km west of Townsville. Specimens were collected on 11 October 1980 and 21 February 1981. This species was previously recorded as far south as Paluma (Common and Waterhouse 1981).

Chaetocneme porphyropis (Meyrick and Lower). This species is seldom taken and specimens have mainly been collected in the Kuranda area. On 22 February 1978 a specimen was taken in rain forest 6 km east of Babinda in the Graham Range.

Tagiades japetus janetta Butler. It appears that this species may be actively extending its range southward as suggested by J. F. R. Kerr (Common and Waterhouse 1972: 75). At that time the southern known limit was Paluma.

Common and Waterhouse (1981) record the species as far south as Proserpine and Shute Harbour. On 7 April 1980 one specimen was taken and discarded and others seen at Jim Crow Mountain, Yeppoon (A. J. Johnson, pers. comm.).

Trapezites heteromacula Meyrick and Lower. This skipper is generally considered rare throughout its known range from Cape York to Kuranda (Common and Waterhouse 1981). A male was taken on 14 March 1980 flying in savannah woodland at the southern extremity of the Paluma Range, 16 km south-west of Bluewater and 40 km west of Townsville.

Toxidia rietmanni parasema (Lower). A male of this northern subspecies was taken on 24 February 1980 at Paluma. Further specimens were taken between 4 October and 19 October 1980 at the southern extremity of the Paluma Range, 40 km west of Townsville. The southern limit given in Common and Waterhouse (1981) is Herberton.

Neohesperilla senta (Miskin). Several specimens were collected near Bluewater Creek, 1 km north-east of Bluewater, on 23 February 1980 and 1 March 1980. This record extends the known range of the species south to Townsville.

Hesperilla sexguttata Herrich-Schäffer. A single specimen of this rather elusive species was collected adjacent to Ollera Creek, 60 km north-west of Townsville on 7 April 1980. Another was taken at Cape Cleveland east of Townsville on 20 April 1980. This species was previously known from the Townsville district only from Magnetic Island (Atkins 1978).

Suniana lascivia neocles (Mabille). Common and Waterhouse (1981) record this species in north-eastern Queensland south to Ingham. In March 1980 two males were collected at the southern end of the Paluma Range, 40 km west of Townsville and some 16 km south-west of Bluewater.

LYCAENIDAE

Acrodipsas brisbanensis (Miskin). The distribution of the most northern subspecies is eastern New South Wales and south-eastern Queensland as far north as the Bunya and Glasshouse Mountains (Common and Waterhouse 1981, Sands 1979). On 29 March 1980 a pair was collected from a hilltop 18 km west of Paluma. Subsequently a male was taken at the same locality on 5 April and another on 19 April 1980. Examination of the male genitalia has confirmed the species identification. This record is most notable, bridging the disjunction in the distribution of the genus between Coen and Expedition Range, and extending the known range of *A. brisbanensis* by 1,200 km.

Hypochrysops pythias euclides Miskin. This species was common at the southern end of the Paluma Range on 11 October 1980. The species appears to be very local and all specimens collected have been flying around clumps of the food plant (*Triumfetta rhomboidea*) or adjacent trees. De Baar (1979) reported rearing larvae from Paluma and we have subsequently found larvae in the Paluma area.

Hypolycaena danis turneri (Waterhouse). Known to extend south to Innisfail (Common and Waterhouse 1981). A fresh specimen was collected along the Wallaman Falls road, 30 km west of Ingham, on 8 March 1980.

Deudorix epijarbas dido Waterhouse. Common and Waterhouse (1981) record the southern limit of this subspecies as Tully, and throughout its range it is not common. In March 1980 a male was taken along Wallaman Falls road, 30 km west of Ingham, and on 17 February 1980 several males were collected in fresh condition from a hilltop near the Black River, 17 km west of Townsville.

Zetona delospila (Waterhouse). Originally known only from the Kimberley region of Western Australia specimens have more recently been taken from near Fairview in far north Queensland (Monteith and Hancock, 1977). In early May 1980 specimens were common at Porcupine Gorge National Park about 70 km north of Hughenden. No specimen was netted but several close-up 35 mm slides were taken by Mr David Thomae of Cairns and these enabled positive identification of this distinctive species. On 16 May 1981 some forty specimens were seen at the same locality by the authors despite inclement weather.

Danis danis serapis Miskin. A specimen was netted in Townsville in May 1977 and another taken on 11 October 1980 south-west of Bluewater about 40 km west of Townsville. The species is recorded as far south as the Paluma Range (Common and Waterhouse 1981).

Megisba strongyle nigra (Miskin). The previously known southern limit of this small and unobtrusive lycaenid is given in Common and Waterhouse (1981) as Paluma. Between 2 February and 25 April 1980 several specimens were taken on Mt Stuart, Townsville.

Acknowledgements

The authors wish to thank Mr A. J. Johnson of Brisbane and Mr David Thomae of Cairns for permission to refer to their unpublished observations. Advice from Mr M. S. Moulds on the preparation of this paper is also acknowledged.

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AGGREGATION OF ADULTS IN TWO AUSTRALIAN SPECIES OF COCCINELLIDAE (COLEOPTERA)

By C. N. Smithers and G. A. Holloway

The Australian Museum, 6-8 College St, Sydney, Australia, 2000.

Abstract

Massive aggregations of adult ladybird beetles (Coccinellidae) are well known in several parts of the world. There are, however, very few records of the phenomenon in Australia. Observations on *Cissella furcifera* (Guérin-Méneville) and *Harmonia conformis* (Boisduval) are reported and discussed.

Observations

Cissella furcifera (Guérin-Méneville)

During May 1981 specimens of *C. furcifera* were collected at several localities in South Australia, as follows: Old Billa Kalina HS, 29°55'S, 136°11'E, 14.v.1981; Lake Eyre South, 14.v.1981; Jersey Springs, 29°20'S, 136°45'E, 15.v.1981; Horse Springs, 29°29'S, 136°55'E, 16.v.1981; Parachilna Gorge, 14 km E Parachilna, 31°12'S, 138°28'E, 17.v.1981; Horrock's Pass, 32°38'S, 138°02'E, 19.v.1981.

The specimens taken at Horrock's Pass were from an aggregation of over 200 specimens found under bark on the lee side of the trunk of a *Eucalyptus* tree (Fig. 1). Conditions at the time were overcast, with a very strong SSE wind and a temperature of 8°C. This appears to be the first record of aggregations of adult *C. furcifera* (G. A. Holloway obs.).

Harmonia conformis (Boisduval)

On 25.xi.1978, and again on 1.i.1979, large numbers of *H. conformis* were seen in flight around a house situated near the top of a hill (720 m) at Tuglo Wildlife Refuge, 48 km N of Singleton, New South Wales. Although counts were not made, thousands of specimens were involved as spectacular dense swarms flew over an area of about a half hectare. Aggregations of settled specimens were not found although subsequent observations at the same site, noted below, suggest that the swarms were probably associated with aggregations forming and dispersing.

The following notes were made on subsequent aggregations at the same locality:—

26.x.1979. Large aggregations found on a post behind a rain gauge.

30.xii.1979. Large aggregations behind downpipes, fascia boards and swallow's nest platforms against wall below eaves of house.

1.i.1980. 18.00 hrs. Hundreds of beetles seen to emerge from aggregation sites to drink at drops of water on the walls, fascia boards and gutters at the eastern end of the house after rain.



Fig. 1. Part of the aggregation of *Cissella furcifera*, Horrock's Pass, South Australia.

2.i.1980. Aggregations reformed, walls etc. dry.

27.i.1980. Aggregations found at bottom of clumps of *Poa labillardieri* Steud. (Poaceae) about 400 m from house.

27.i.1980-2.ii.1980. 33 mm of rain fell during this period by the end of which all aggregations had dispersed.

x.1980. Small aggregations of a few specimens each and apparently aestivating individuals found in leaf axils of *Protea* spp. at site of *Poa labillardieri* previously holding aggregations (i.e. 400 m from house).

xi.1980. Similar aggregation to that during x.1980 but fewer specimens involved.

20-21.iv.1981. Aggregations not found but a few individuals seen behind gutters, downpipes etc. A few specimens flying around house, settling on

walls and other vertical surfaces of the house and taking flight again. (C. N. Smithers obs.).

Discussion

Anderson and Richards (1977) reported aggregations of adult coccinellids in Australia and discussed them in relation to factors thought to induce diapause. They pointed out that there are very few records of summer aggregation, the only Australian species for which they had such a record being *Scymnodes lividigaster* (Mulsant). They noted that aggregation was apparently associated with a very dry season which had immediately preceded its formation—possibly acting through reduced food supply. *C. fuscifera* appears, on the limited data so far available, to conform to the more usual pattern of winter aggregations discussed by Anderson and Richards (*loc. cit.*).

They also reported several instances of winter aggregation in *H. conformis*. The only earlier report of aggregation in that species is, however, of a summer aggregation (Smithers 1970). From the combined records now available, namely those of Smithers (*loc. cit.*), Anderson and Richards (1977) and those given above, it is clear that *H. conformis* aggregates in both summer and winter and that the aggregations can persist for several months. The summer aggregations were recorded during a series of exceptionally dry years (as in the case of *S. lividigaster*) and the reactions of the aggregating individuals to a shower of rain, and their dispersal following substantial rain at the end of January 1980, suggest that moisture may be important in control of aggregation as well as the temperature, photoperiod and food factors suggested by earlier authors e.g. Anderson and Richards (1977) and McMullen (1967). In the erratic climatic regimes to which much of Australia is subject it would seem reasonable to expect that the ladybirds would adopt opportunistic behaviour towards such factors as rain which might lead to a change in food availability.

The field information so far available suggests a complex physiological and ecological relationship which would be well worth investigating on an experimental basis.

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TWO NEW SPECIES OF AUSTRALIAN *BEMBIX* SAND WASPS, WITH NOTES ON OTHER SPECIES OF THE GENUS (HYMENOPTERA, SPHECIDAE)

By Howard E. Evans

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Abstract

Two new species of *Bembix* are described from Northern Territory: *gurindji* (Daly River) and *obiri* (near Mt. Cahill). The female of *B. kununurra* is described for the first time, and range extensions are given for three other species.

Introduction

In a recent review of the biosystematics of Australian *Bembix* sand wasps, 80 species were recognised (Evans and Matthews, 1973). Extensive collecting of these wasps during the summer of 1979-1980 tended to confirm the conclusions set forth in that review, but two new species were found in series in the collection of the Department of Primary Production, Darwin, the female of *B. kununurra* was collected for the first time, and three species were collected from well outside their previously known ranges. In the descriptions, the terminology of Evans and Matthews (1973) has been followed.

Bembix gurindji sp. n.

(Figs 1, 2, 4)

MALE

Morphology. Length 19.5 mm; fore wing 12.5 mm; wing index 1.82. Mandibles robust, moderately curved, index 2.0. Clypeus 2.0 x as wide as high, strongly protuberant and abruptly flattened on apical two-thirds, flattened area distinctly punctate. Front narrow, minimum width 0.53 x eye height, centre of vertex well below level of eye tops. Scape robust, twice as long as wide; third antennomere 2.7 x as long as wide; outer antennomeres strongly modified, as figured for *B. mareeba* (Evans and Matthews, 1973, fig. 118). Fore femur unmodified, 2.8 x as long as wide; fore tibia much broadened from base; fore basitarsus much expanded and shield-like, 1.6 x as long as maximum width, outer margin with a series of nine strong, black lobes and bearing 15 pecten spines; under surface of tarsus with a pattern of black as figured. Mid femora spinose beneath for their entire length; mid tarsomeres 2-4 strongly compressed. Tergite 7 with protruding, truncate median apical lobe, its lateral lobes slender, finger-like. Sternite 2 with a strong median process arising from base and extending nearly to apex. Sternite 6 simple; sternite 7 subtruncate apically, lateral margins with a brush of dense, long setae basally; sternite 8 attenuate, tip narrowly rounded. Parameres acuminate and densely setose subapically, flanges large, angular; cuspides rounded apically; digiti rod-like, slightly shorter than cuspides.

Coloration. Scape yellow, with a narrow black streak above and a small apical black spot; flagellum fuscous above, rufous beneath; mandibles, labrum, and clypeus light yellow; front yellow except black at ocellar area and with

* These studies were conducted while the author held a research fellowship at the Univ. of Queensland, and a travel grant from the National Geographic Society, U.S.A.

a pair of spots above antennal sockets barely connected to ocellar black; vertex black, barely connecting eye tops; occiput black but outer orbits yellow. Pronotum yellow; mesoscutum black except longitudinally yellow on sides and with paired yellow discal streaks which taper behind and are not connected to a yellow spot medioposteriorly; scutellum with a transverse white band, interrupted medially; metanotum with a complete white band; propodeum with a dorsal V-shaped white marking, light yellow laterally; pleura and venter yellow. Legs yellow except fore tibiae with several small black spots behind, fore tarsi patterned as figured; mid and hind legs black at femorotibial joints and tibiae with limited black markings. Tergite 1 with a transverse, sinuate white band; tergite 2 with a broad white band, nearly encircling black spots and interrupted medially; T3-6 with white bands biemarginate anteriorly, on 3 and 4 narrowly interrupted medially; tergite 7 with a median white spot; venter light yellow except process on sternite 2 streaked with black, also with median black spots on sternites 3 and 4, sternites 5 and 6 transversely black, sternite 7 black. Wings hyaline.

FEMALE

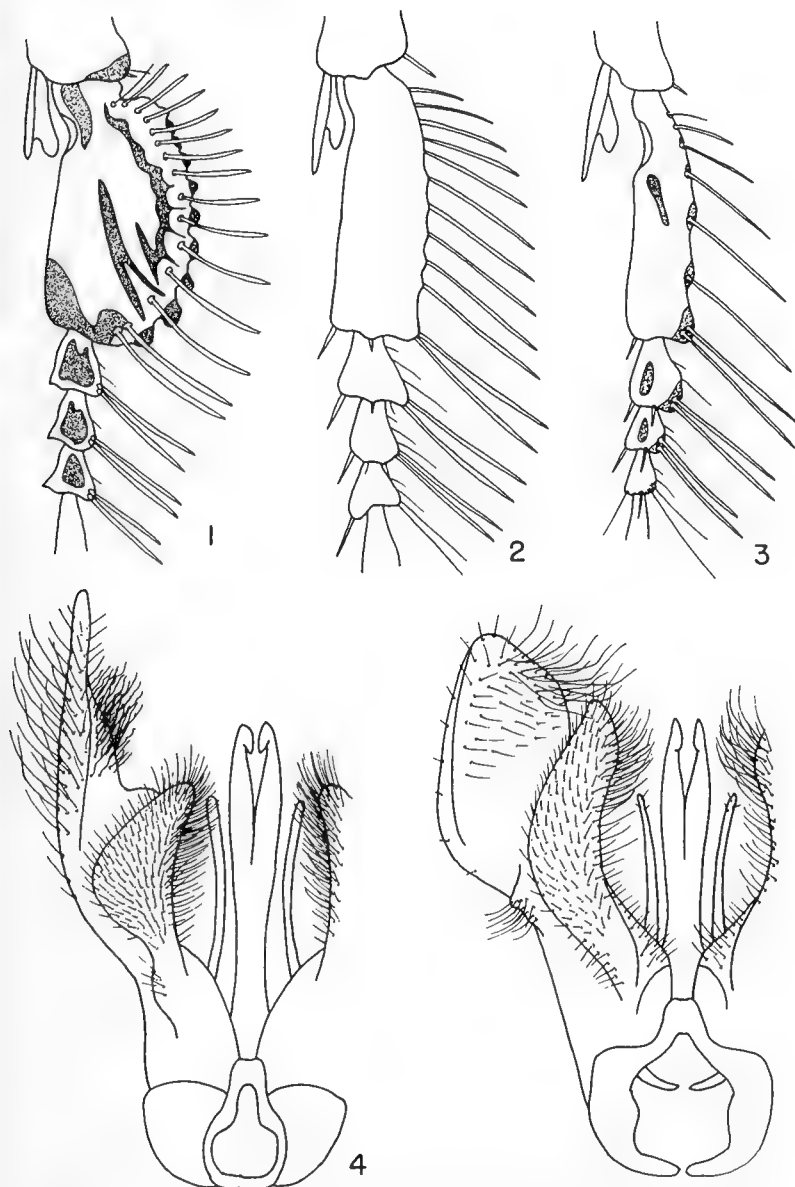
Morphology. Length 17.5 mm; fore wing 12.5 mm; wing index 1.85. Mandibles robust, strongly curved, tooth and cutting edge well developed, index 1.9. Clypeus 2.1 x as wide as high, protuberant, abruptly flattened over apical 0.7, flattened area with several strong punctures. Minimum width of front 0.56 x eye height; centre of vertex well below level of eye tops. Scape 2.8 x as long as wide; third antennomere 4.2 x as long as wide. Fore basitarsus somewhat broadened and flattened, 3.0 x as long as wide, bearing 12 pecten spines, most basal one quite small. Mesoscutum densely punctate, somewhat shining between punctures. Sternite 2 with sparse, coarse punctures except at extreme base and sides; tergite 6 coarsely punctate and with stiff lateral bristles.

Coloration. Similar to male except as follows: scape with a broader black streak; clypeus with a pair of large black spots; mesoscutal markings forming a complete U; markings on scutellum, metanotum, and propodeum broader and yellow in colour rather than white; metasomal markings light yellow to white, band on tergite 2 enclosing black spots, tergite 6 with a large white spot; venter largely yellow except for median black on sternites 4 and 5, sternite 6 black. Legs yellow except fore femora and tibiae streaked with black, mid and hind femora spotted with black apically and tibiae streaked with black.

MATERIAL STUDIED. *Holotype* ♂ and *allotype* ♀, Beeboom Crossing, Daly River, on Tipperary Station, Northern Territory, 28.xi.1972, T. Angeles and N. Forrester (Australian National Insect Collection, Canberra). *Paratypes*: 3 ♀♀, same data as type; 1 ♀, Swim Creek, Northern Territory, 13.x.1971, T. Weir and A. Allwood; 1 ♀, Wildman River, at Arnhem Highway, Northern Territory, 26.xi.1974, T. Weir and T. Angeles (Dept. Primary Production, Darwin); 3 ♀♀, Mt. Hart (in King Leopold Range, NE of Derby), Western Australia, 1-2.ii.1965, A. Douglas (Western Australian Museum, Perth).

DISCUSSION

A single female of this wasp was treated by Evans and Matthews (1973) as a variant of *mareeba* Evans and Matthews, of small size and having a white



Figs 1-5. (1-2) *Bembix gurindji* sp. n.: (1) basal segments of fore tarsus of ♂, viewed from beneath; (2) basal segments of fore tarsus of ♀, viewed from above. (3) *Bembix obiri* sp. n., basal segments of fore tarsus of ♂, viewed from beneath. (4) *Bembix gurindji* sp. n., ♂ genitalia, ventral aspect. (5) *Bembix obiri* sp. n., ♂ genitalia, ventral aspect.

spot on the apical tergite. Now that a longer series is available, including a male, it is clear that this is a discrete species. Females will key to *mareeba* but have a narrower front, a slightly less expanded front tarsus and 11 or 12 pecten spines on the basitarsus, as well as smaller average size and a maculated apical tergite. The male is immediately separable from related species by virtue of the 15 pecten spines and black lobes on the front basitarsus; the form of the clypeus is also distinctive.

The females in the type series vary from 15 to 18 mm in length and have either 11 or 12 pecten spines on the basitarsus. In one specimen the discal markings on the mesoscutum do not quite form a complete U, and in two the white band on tergite 2 does not completely enclose black spots.

The species name *gurindji* is aboriginal and is that of a tribe which formerly inhabited the area of the type locality.

Bembix obiri sp. n.

(Figs 3, 5)

MALE

Morphology. Length 16 mm; fore wing 11 mm; wing index 1.65. Mandibles weakly curved, tooth and cutting edge well developed; clypeus 1.75 x as wide as high, protuberant and strongly flattened medially on apical 0.6. Front narrow, minimum width 0.53 x eye height; centre of vertex slightly below level of eye tops. Scape 2.7 x as long as wide; third antennomere 3.2 x as long as wide. Fore femur simple, 3.3 x long as wide; fore basitarsus 3.6 x as long as wide, outer margin with a series of rounded, black lobes bearing eight pecten spines; tarsomeres 2-4 also each bearing a black lobe laterally, and 1-3 each also with a black spot beneath. Mid femur with a series of sharp teeth beneath; mid tibia spinose at base of spur; mid tarsi unmodified. Tergite 7 with margins somewhat sinuate, convergent to a very shallowly emarginate apex. Sternite 2 with a curved, spinose process toward apex; sternite 6 with a rather weak, vaguely triangular subapical process; sternite 7 with a strong median carina apically; sternite 8 in the form of a downcurved spine. Parameres broad, inner margin strongly setose subapically; cuspides densely setose, slightly exceeding aedeagus; digiti rod-like.

Coloration. Scape yellow, streaked with black above; flagellum dark above, yellow to light brown beneath; mandibles and labrum white, clypeus white but suffused with yellow above; front yellow, eye tops connected by a black band which extends over ocellar area and nearly to antennal sockets; outer orbits yellow but vertex and occiput black. Pronotum yellow; mesoscutum black, with a U-shaped yellow discal marking and yellow on extreme sides; scutellum and metanotum black but each transversely marked with yellow; propodeum black dorsally, with yellow banding, laterally largely yellow; mesopleura and venter largely yellow. Legs yellow except femora streaked with black, coxae partly black, black at femorotibial joints, and fore tarsi blackened as described above. Tergite 1 black, with transverse yellow band; tergites 2 and 3 broadly banded with yellow, band on 2 enclosing a pair of black spots, that on 3 nearly enclosing such spots; tergites 4-6 with yellow bands biemarginate anteriorly; tergite 7 with a median yellow spot;

venter largely yellow laterally, black medially, the black broadening posteriorly so that sternite 6 is all black. Wings hyaline.

FEMALE

Morphology. Length 16.5 mm; fore wing 11.8 mm; wing index 1.65. Mandibles robust, strongly curved, index 2.1. Clypeus 1.95 x as wide as high, protuberant and flattened as in male. Minimum width of front 0.53 x eye height; centre of vertex slightly below level of eye tops. Scape 3.0 x as long as wide; third antennomere 4.5 x as long as wide. Fore femur 3.0 x as long as wide; fore basitarsus flattened, gradually broadened from base, 2.9 x as long as its greatest width, outer margin not darkly pigmented, weakly lobed, bearing 8 pecten spines. Mesoscutum shining, densely micropunctate; sternite 2 sparsely punctate medially, much more densely so laterally; tergite 6 with sparse, shallow punctures.

Coloration. Essentially as in male except yellow maculations of mesosoma somewhat broader, those on metasoma also broader, band on tergite 3 fully enclosing black spots, tergite 6 with a large median yellow spot.

MATERIAL STUDIED. *Holotype* ♂ and *allotype* ♀, 16 km E by N of Mt. Cahill, Northern Territory, 12°50'S 132°51'E, 13.vi.1973, T. Weir and T. Angeles (Aust. Nat. Insect Coll., Canberra). *Paratypes*: 1 ♂, 1 ♀, same data as type (Dept. Primary Production, Darwin).

DISCUSSION

The male runs to couplet 63 in Evans and Matthews (1973) but the fore basitarsus is intermediate in development between *oomborra* and *goyarra*. In other features expressed in the couplet (vertex below eye tops and black lobes on front basitarsus) agreement is with *oomborra*, which was described from a single male from Darwin. I at first thought these specimens might fall within the range of variation of *oomborra*, but clearly this is not the case, as the genitalia are very different, especially the much broader parameres. Also, the fore basitarsus is notably broader and more strongly lobed and the body is much more extensively maculated. The female runs to *loorea* Evans and Matthews, described from central Australia, and the fore basitarsus is much as figured for that species. It differs, however, in having the centre of the vertex below the level of the eye tops and in having U-shaped yellow scutal markings, black streaks on the femora, and enclosed black spots on tergites 2 and 3.

The species is named for Obiri Rock, near Mt. Cahill, the site of extensive aboriginal rock paintings.

Bembix kununurra Evans and Matthews

FEMALE

Morphology. Length 14 mm; fore wing 11 mm; wing index 1.8. Mandibles slender, slightly curved, tooth small but cutting edge well developed, index 2.4, total length 6.2 x minimum width basal of tooth. Clypeus 2.0 x as wide as high, rounded in profile. Minimum width of front 0.61 x eye height; centre of vertex level with eye tops. Scape 3.3 x as long as wide; third antennomere 4.4 x as long as wide. Fore femur 3.0 x as long as wide; fore basitarsus 3.0 x as long as wide, without dark pigmentation, outer margin serrate and bearing 6 pecten spines which decrease gradually in length towards base. Mesoscutum moderately shining, closely punctate; sternite 2 weakly depressed and coarsely

punctate medially, with small punctures laterally; tergite 6 and sternite 6 both with dark median streaks which are very slightly elevated.

Scape yellow except black above on apical 0.7; flagellum yellow beneath on basal third, beyond that testaceous beneath; mandibles and clypeus light yellow, labrum nearly white; front, vertex, and occiput yellow, blackened at ocelli and with a black streak above each antennal socket, also a small black spot at each upper, inner eye margin. Pronotum yellow; mesoscutum yellow except for 3 narrow black, longitudinal streaks, median streak not reaching posterior margin; scutellum transversely black at base, otherwise yellow; metanotum yellow; propodeum yellow except transversely black at base and with a pair of narrow, oblique black stripes; mesopleura and venter wholly yellow. Propodeum and tergite 1 with unusually dense, woolly hair. Legs yellow except femora and tibiae streaked with black and with some black at the coxa-trochanter and femur-tibia joints. Metesoma wholly yellow except for small black spots on tergite 1 and narrow apical black bands on all tergites, also median black streaks on the apical tergite and sternite. Wings hyaline.

MATERIAL STUDIED. 2 ♀, 1 ♂, 5 km N of Kununurra, Western Australia, 20.ix.1979, H. E. and M. A. Evans (1 ♀ in Australian National Insect Collection, Canberra, 1 ♀, 1 ♂ in University of Queensland, Brisbane).

DISCUSSION

This species was described from a single male from Kununurra. Like the male, the female is by far the most extensively maculated Australian *Bembix*, appearing virtually entirely yellow in the field. The dense, woolly pile on the propodeum and first metasomal tergite is also characteristic. The female will run to couplet 38 in the key of Evans and Matthews (1973) but fits neither half of the couplet well, as the mandibles are intermediate in structure.

Bembix wiluna Evans and Matthews

This species ranges through arid parts of the continent, from central New South Wales to Western Australia. It is not surprising to report it for the first time from Queensland, a pair taken 9 km S of Charleville, 18.x.1978, by J. C. Cardale (Australian National Insect Collection, Canberra).

Bembix allunga Evans and Matthews

This species has been reported from coastal localities from central Queensland to northeastern Western Australia. It is here reported from an inland locality well south of its previously known range: several females taken 10 km S of Coonabarabran, New South Wales, 15.i.1980, by H. E. and M. A. Evans and A. Hook (University of Queensland, Brisbane).

Bembix thooma Evans and Matthews

This species is here reported from Queensland for the first time, a male taken at Cunnamulla, 27.x.1979 by H. E. and M. A. Evans and A. Hook (University of Queensland, Brisbane). This wasp is widely distributed in the interior and is known to prey on wasps of the subfamily Thynninae.

Reference

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**APHYOPSOCUS GEN. NOV., A REMARKABLE NEW GENUS
OF CAECILIIDAE (PSOCOPTERA) FROM SOUTH-EASTERN
NEW SOUTH WALES**

By C. N. Smithers

The Australian Museum, 6-8 College St., Sydney

Abstract

A remarkable new genus, *Aphyopsocus*, in the psocopteran family Caeciliidae is described in which the adults and nymphs have the epiproct conspicuously enlarged, the vertex of the female flattened and the first flagellar segment of the antennae enlarged in both sexes.

Introduction

Mockford (1978) has discussed the problems of classification of the group of psocopteran families included in the Caecilietae. As a result of recent investigations it has been suggested (Mockford and Garcia Aldrete 1976) that the group be divided into the superfamilies Asiopsocoidea (with a single family) and the Caecilioidea (to hold the remaining genera). These genera Mockford (1978) has regrouped into three families, the first of which he did not name, the Caeciliidae (which he redefined) and the Amphipsocidae which he classified in detail.

Material in the Australian Museum includes specimens of an interesting and remarkable new species which has been taken at many localities in south eastern New South Wales and which, whilst clearly a member of the Caeciliidae, cannot be placed in any described genus without considerable change to generic limits. It is, therefore, described here as a new genus, *Aphyopsocus*. All specimens have been taken in wet sclerophyll or rainforest habitats.

***Aphyopsocus* gen. nov.**

Belonging to the Caeciliidae (*sensu* Mockford 1978) with the following combination of characters: Antero-lateral setae of labrum not heavier than other labral setae; mandibles elongate; abdominal vesicles present; labral sensilla obscure; labral stylets well developed; wings elongate; no lateral apophyses on subgenital plate; first flagellar segment thickened in both sexes; epiproct developed into setose dome in both sexes; marginal setae of male hypandrium not grouped; gonapophyses of female with large external valve remnant, sometimes with more than one seta; spermathecal duct sheath enclosing most of duct. Nymphal epiproct greatly extended into a long protuberance.

Type species: *Aphyopsocus prolixus* sp. n.

Aphyopsocus falls well within the definition of the family Caeciliidae, as redefined by Mockford (1978). Two subfamilies are currently recognized: 1. Dypsocinae, in which the head is strongly compressed antero-posteriorly, so that the vertex is very sharp and often has a median cleft. 2. Caeciliinae in which the vertex is either rounded, or the head has a somewhat flattened

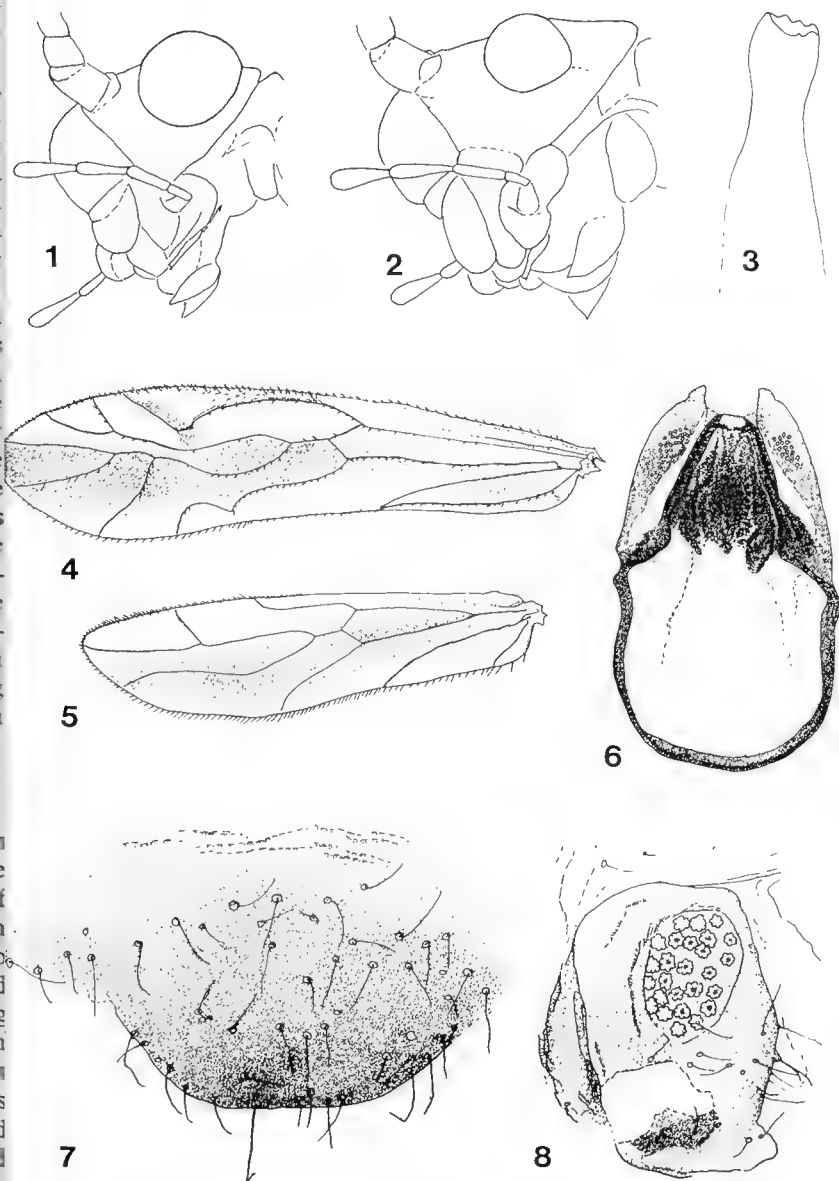
vertex. *Aphyopsocus* clearly falls within the Caeciliinae, in which ten genera are recognized at present. The main differences between these genera and *Aphyopsocus* can be summarized as follows. Both *Ypsiloneura* Pearman and *Mepleres* Enderlein differ from *Aphyopsocus* in having a 2-branched media, which is 3-branched in all other macropterous members of the subfamily. *Smithersiella* Badonnel lacks ocelli and the gonapophyses lack setae but the subgenital plate has distinct lateral apophyses. In *Mockfordiella* Badonnel M of the fore wing is not sinuous, the subgenital plate has a posterior median lobe and the paraprocts have a field of tubercles. *Paracaecilius* Badonnel and *Enderleinella* Badonnel have broad gonapophyses, with a small external valve remnant; in *Paracaecilius* the anterior end of the phallosome is open and in *Enderleinella* the apex of the lacina is extended into an apical point. In *Fulleborniella* Enderlein the pterostigma has a spurvein and the gonapophyses consist of two acuminate valves and a small external valve remnant. From *Caecilius* Curtis *Aphyopsocus* can be distinguished by the large external valve and the sinuous vein M in the fore wing. *Lacroxiella* Badonnel is poorly known but has wings which are narrowed apically to a rounded end; the pterostigma has no pronounced hind angle and the veins and margin are sparsely setose. *Austrocaecilius* Smithers has a glabrous external gonapophysis valve which is elongate and well sclerotized; the dorsal and ventral valves are long and slender and the subgenital plate has very conspicuous lateral apophyses which bear marginal setae. In addition to the differences indicated above *Aphyopsocus* differs from all other genera of the Caeciliinae in the enlargement of the epiproct in the adults into a setose dome-shaped structure and in the nymphs into a conspicuous, well developed, elongate, apically narrowing extension of unknown function; this extension is half as long as the abdomen in some instars.

Aphyopsocus prolixus sp. n.

MALE

Coloration (in alcohol). Head very pale brownish yellow with a brown median, longitudinal stripe from occiput to epistomial suture; stripe a little wider at ocellar tubercle. Postclypeus pale brown with faint suggestion of darker, anteriorly converging lines; postclypeus paler around edge. Labrum colourless. Maxillary palps colourless. Genae pale brown, paler adjacent to postclypeus. Scape, pedicel and first flagellar segment dark brown; second flagellar segment pale in basal half, darkening to brown distally; remaining segments brown. Eyes black. Ocelli pale on brown tubercle. Mesothorax with antedorsum and dorsal lobes shining brown; paraspidal sutures and a median stripe broadly very pale brownish yellow; scutellum pale. Metanotum as mesonotum but antedorsum pale. Pleura brown. Fore wings (Fig. 4), hind wings (Fig. 5) hyaline with some brown areas. Legs colourless with second tarsal segment pale brown. Abdomen colourless with black spot at apex caused by subcutaneous pigments in the prominent epiproct.

Morphology. Length of body: 2.6 mm. Median epicranial suture very distinct. Top of head (Fig. 1) fairly flat so that hind margin is level with



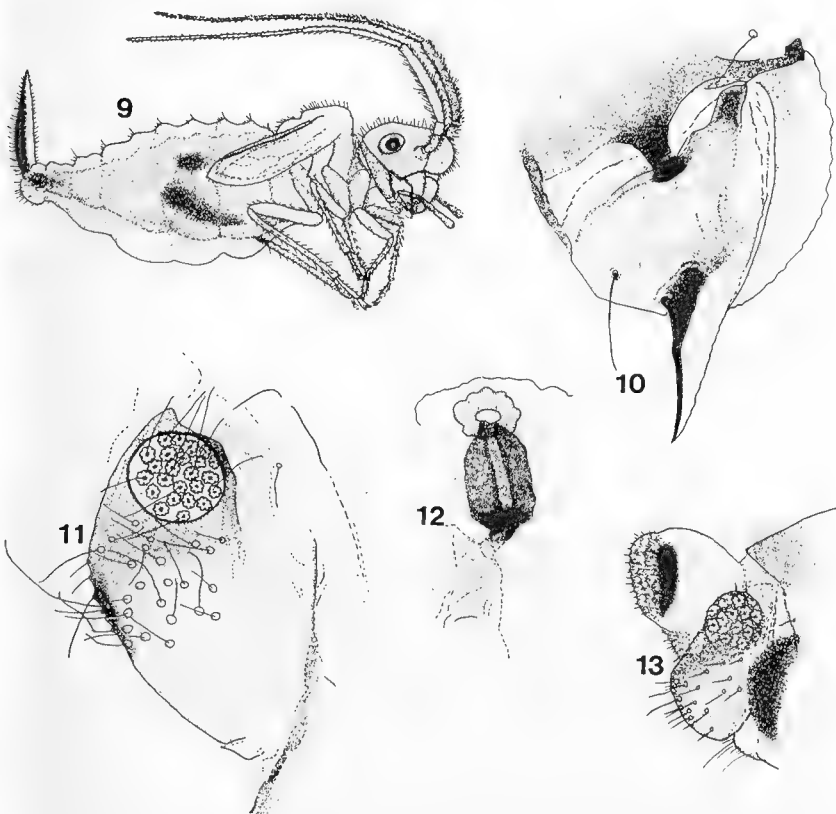
Figs 1-8. *Aphyopsocus prolixus* sp. n.: (1) ♂ head; (2) ♀ head; (3) ♂ lacinia; (4) ♀ fore wing; (5) ♂ hind wing; (6) ♂ phallosome; (7) ♂ hypandrium; (8) ♂ paraproct.

pronotum. Postclypeus bulbous. Head with fine setae, except on genae. Labrum with well developed antero-lateral stylets. Antero-lateral setae of labrum not heavier than others. Full complement of marginal labral setae present. Genae broad with little distance between eye and base of mandible. Lengths of flagellar segments: f_1 : 1.04 mm; f_2 : 0.84 mm. First flagellar segment much thicker than second, slightly curved. Setae fine and short. Eyes large, just reaching level of vertex. IO/D: 1.1; PO: 0.82. Ocellar tubercle ovoid with longitudinal axis greater than transverse. Ocelli of equal size. Mandibles relatively long (*sensu* Mockford and Garcia Aldrete 1976). Lacinia (Fig. 3). Maxillary palps very long, fourth segment three times longer than wide at its widest point; second segment almost as long as fourth segment but narrower. Measurements of hind leg: F: 0.76 mm; T: 1.28 mm; t_1 : 0.35 mm; t_2 : 0.13 mm; rt: 2.7: 1; ct: 15, 0. No cones on anterior face of femora of prothoracic leg. Fore wing length: 4.0 mm; width: 1.0 mm. Wings remarkably long and narrow (Fig. 4), some four times long as wide. Hind angle of pterostigma strong; ptersostigma long. Rs and M confluence fairly long, beyond which Rs is gently sinuous and approaches M closely. Stem of Rs about three times as long as radial fork. M, beyond separation from Rs, curving back and then forwards strongly to approach Rs. Cu, slightly sinuous basad of areola postica. Setae on veins short, fine and sparse, in a single row. Hind wing length: 3.2 mm; width: 0.8 mm. Hind wings (Fig. 5) narrow and long. Margin setose from about R_1 , around tip to base on hind margin. Veins without setae. No basal anterior setal brush. Epiproct developed into an unusual, large, postero-dorsal, setose dome (representing reduced epiproct as seen in nymph, see below and Fig. 9). Paraproct (Fig. 8) simple, without duplex seta on posterior margin and without papillae. Hypandrium (Fig. 7) sparsely setose, a little more heavily sclerotized near hind margin than elsewhere. Marginal setae not grouped. Phallosome (Fig. 6) closed anteriorly; posterior fusion of inner parameres lightly sclerotized; penial bulb with sclerotizations; external parameres fairly broad with sensory pores grouped into a more or less defined field remote from apex.

FEMALE

Coloration (in alcohol). As in male but dark areas darker in most specimens. Antennae as in male but second, third and fourth flagellar segments pale in basal half, each becoming darker in distal part. Black spot at end of abdomen a little more conspicuous than in male due to greater prominence of epiproct.

Morphology. Length of body: 3.1 mm. Head (Fig. 2) flat on top, much more so than in male, vertex hardly higher than pronotum. Hind margin of head capsule emarginate at epicranial suture. Postclypeus bulbous. Labrum as in male. Genae very broad to correspond with elongation of top of head and frons. Length of flagellar segments: f_1 : 1.1 mm; f_2 : 0.84 mm. Antennae with scape, pedicel and first flagellar segment thickened; first flagellar segment much thicker than in male and more distal flagellar segments. Setae fine and



Figs 9-13. *Aphyopsocus prolixus* sp. n.: (9) ♀ nymph; (10) ♀ gonapophyses; (11) ♀ paraproct; (12) spermathecal entrance and duct; (13) ♀ epiproct and paraproct, right lateral.

dense. Eyes smaller than in male, not reaching level of flattened top of head. IO/D: 1.8; PO: 0.66. Ocelli smaller than in male but on similarly ovoid tubercle. Lacinia as in male. Maxillary palps long, as in male. Measurements of hind leg: F: 0.84 mm; T: 1.36 mm; t_1 : 0.36 mm; t_2 : 0.16 mm; rt: 2.3: 1; ct: 18, 0. Fore wing length: 4.3 mm; width: 1.1 mm. Hind wing length: 3.4 mm; width: 0.8 mm. Wings as in male. Epiproct (Fig. 13) enlarged into a setose dome, longer than in male; the dome representing the extremely well developed epiproct of the nymph (see below and Fig. 9). Paraproct (Fig. 11). Subgenital plate simple, thickened along border, setose. Gonapophyses (Fig. 10); ventral valve long, curved, slightly tapering, arising from a strongly sclerotized bar and with a lightly sclerotized ventral flange; dorsal valve well sclerotized, broad at base, tapering posteriorly to a fine point, with a ventral, lightly sclerotized flange; external valve remnant very broad and unusually well developed for the family, with from one to three setae (one in figure).

Spermathecal duct (Fig. 12) with short duct most of which is enclosed in the sheath (*sensu* Mockford 1978); entrance to spermatheca surrounded by a lightly sclerotized but distinct ring.

NYMPH (Fig. 9)

Coloration. White, except for the black or dark brown eyes.

Morphology. Differences in head shape and development of the first flagellar segments of the antennae, as seen in adult males and females, are discernible in nymphs from at least the penultimate nymphal instar. The most remarkable feature of the nymphs is the extraordinary development of the epiproct into a large dorso-posterior spike. Such development has not previously been reported in the Psocoptera. It is also unusual for a species with well pigmented adults to have colourless nymphs.

MATERIAL EXAMINED. NEW SOUTH WALES:— *Holotype*, ♂, Lindfield, 28.x.1962, A. S. Smithers. *Allotype*, ♀, Lindfield 19.xi.1970, C. Trickett. *Paratypes*: 5 ♂, 2 ♀, same data as holotype. 2 ♂, 2 ♀, Lindfield, 7.x.1961, A. S. Smithers. 1 ♂, 3 ♀, Lindfield, 10.xi.1970, A. S. Smithers. 1 ♀, Lindfield 19.xi.1970, J. O'Regan. 5 ♂, 3 ♀, Lindfield, 19.xi.1970, C. Trickett. 1 ♀, Lindfield, 10.xii.1966, J. V. Peters. 1 ♀, Lindfield, 4.v.1976, C. N. Smithers. 1 ♀, Lindfield, 27.i.1961, C. N. and A. S. Smithers. 1 ♀, Upper Causeway, Royal National Park, 3.xii.1966, C. N. and A. S. Smithers. 1 ♀, Royal National Park, 25.ii.1961, C. N. and A. S. Smithers. 1 ♂, Royal National Park, 29.i.1961, C. N. and A. S. Smithers. 2 ♂, 3 ♀, Royal National Park, 6.x.1965, A. S. Smithers. 2 ♂, Couranga Track, Royal National Park, 10.xi.1976, G. A. Holloway. 1 ♀, Royal National Park, 20.ix.1968, J. V. Peters. 2 ♀, Northmead, 26.i.1963, D. K. McAlpine. 1 ♀, Northmead, 12.ii.1964, C. N. Smithers. 2 ♂, 1 ♀, Lisarow, near Gosford, 6.vii.1966, C. N. Smithers. 1 ♂, 9 ♀, Bulli Pass, 8.xii.1966, C. N. Smithers. 1 ♂, Narara, near Gosford, 6.vii.1966, C. N. Smithers. 5 ♀, Rutherford Creek, Brown Mt., near Nimmitabel, 19.xi.1976, G. Daniels and M. Schneider (AM). 1 ♂, 1 ♀, Tantawangalo, near Cathcart, 27.iii.1962, C. N. and A. S. Smithers. 1 ♀, Rocky Hall, near Eden, 23.iii.1962, A. S. Smithers. 1 ♂, Bandon Grove, near Dungog, 4.ix.1961, C. N. and A. S. Smithers. 1 ♀, Bega, 22.iii.1962, A. S. Smithers. 3 ♀, Talbingo, 24.iii.1962, A. S. Smithers (BMNH). 1 ♂, Macquarie Falls, 14.xi.1960, D. H. Colless. 1 ♀, Cootes Crossing, Orara River, 26.iii.1961, C. N. and A. S. Smithers. 1 ♀, Captain's Flat, 1.iv.1971, C. N. Smithers (ANIC).

Holotype and paratypes in the Australian Museum (AM), paratypes in the Australian National Insect Collection (ANIC) and the British Museum (BMNH).

Nymphal material: 2 nymphs, Lindfield, 10.xii.1966, J. V. Peters. 1 nymph, Royal National Park, 20.i.1968, J. V. Peters. 6 nymphs, Royal National Park, 29.i.1961, C. N. and A. S. Smithers (AM).

Acknowledgements

I would like to thank Martyn Robinson for preparing the figures for this paper and the collectors who have provided material of this interesting species.

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BOOK REVIEW

Plecoptera (Sternfliegen) by P. Zwick. 1980. iii, 115 pp. *Handbuch der Zoologie* Vol. IV. 2. Hälfte: Insecta 2. Teil Spezielles Lfg. 26, 7.

Handbuch der Zoologie is a handbook of zoology founded by Willy Küenthal, edited by J.-G. Helmcke (Berlin), E. Starck (Frankfurt/M.) and H. Wermuth (Ludwigsburg) and published by Walter de Gruyter, Berlin/New York. It constitutes a natural history of the phyla of the animal kingdom and this volume deals with the stoneflies (Plecoptera).

Under the main chapter headings which roughly translated read History of exploration, Characteristics, Paleontology, Systematics, Distribution and distributional history, Ecology and physiology, Enemies, parasites and commensals, Economics, Anatomy and morphology, Reproduction and life cycle, practically all important literature is not only reviewed in a fascinating style but also constructively criticised and complemented as far as advisable and possible in a general treatment like this. The volume concludes with a register of scientific names and a list of the cited literature (734 titles).

Most chapters, but particularly those concerning systematics, and distribution and distributional history, possibly could not have been written by anyone else more experienced and competent. The author has constantly been working on these themes for more than a decade and has established a phylogenetic system of the order based on the detailed consideration of the subject.

The very interesting Australian forms are treated as far as it is possible to do so in a general work of this kind. Here the fact that the author has spent considerable time in Australia collecting and studying stoneflies and has been, and still is, publishing on our fauna must be considered a benefit.

I regard this volume as a first class, illustrated, up to date encyclopedia of Plecoptera which could be used as an excellent example for any other thorough treatment of an insect group. It fulfils an important need in the entomological literature and is recommended to anyone truly interested in hydrobiology, limnology, and related applied subjects, working as a teacher or student, professional or amateur. It should be present in every zoological institute.

It is obvious that the German name of Plecoptera is not Sternfliegen as printed erroneously on the title pages, but rather Steinfliegen (translated stoneflies) otherwise the volume is remarkably free from typographical errors and well produced. Its price (about A\$62) appears high in relation to the size but not to the quality of the work.

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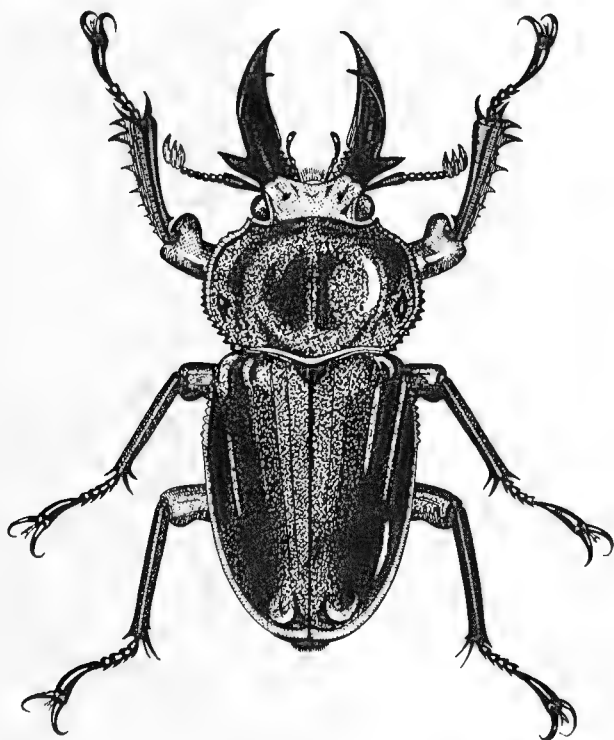
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The large and beautiful stag beetle, *Phalacrognathus muelleri* Macleay (family Lucanidae), is one of Australia's most spectacular beetles. The dominant pigmentation is maroon and green with a brilliant mirror-like sheen. Large males can measure 60 mm or more in length. The species is found only in rain forest in north-eastern Queensland where the larvae feed in decaying logs. Adults fly at dusk and rarely venture beyond rain forest margins.

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BUTTERFLIES OF THE UPPER JARDINE RIVER, CAPE YORK PENINSULA

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Abstract

Forty species of butterflies are recorded from the Jardine River basin. *Telicota eurotas laconia* Waterhouse has not previously been recorded north of the Claudie River (Iron Range), and the known distributions of *Toxidia inornata inornata* (Butler) and *Philiris fulgens kurandae* Waterhouse are marginally extended northwards. Rain forest areas (semi-deciduous mesophyll closed forest) are mapped in detail for the first time and facts concerning river navigation are presented for the benefit of those wishing to enter this little known area.

Introduction

The Jardine River is situated in the far northern portion of Cape York Peninsula (Fig. 1). Although Queensland's largest perennial river its upper reaches have remained unexplored and very little is known of the zoology of this remote area. The first botanical survey of the Jardine River catchment has only recently been made (Lavarack and Stanton, 1977): vegetation types were mapped on a broad scale and extensive areas of closed forest in the upper Jardine basin recorded. Rain forest also occurs immediately to the east and south-east of the Jardine basin in the vicinity of Shelburne Bay (Pedley and Isbell, 1971). These recently discovered rain forests form an area of special biological significance because of its location between the rather different rain forest communities of Cape York and Iron Range. Monteith and Hancock (1977) list the butterfly fauna from the rain forests near

Shelburne Bay. In this paper we list species from the rain forests of the Jardine basin.

The vegetation along the river for much of its length is dominated by *Melaleuca leucadendron* and *Leptospermum longifolium*. The stands of rain forest (semi-deciduous mesophyll closed forest) are limited in extent and occur only along the upper portions of the river. All are riverine in nature with the largest stand covering no more than a few hectares. Almost without exception these rain forest areas are associated with permanent creeks. Predominant canopy trees are *Beilschmiedia obtusifolia* and *Syzygium rubiginosum*. Palms are a prominent feature and many species were encountered, the most conspicuous being *Livistona benthamii* which appeared to be the most widespread species and the large and beautiful fan palm, *Licuala ramsayi*, and the wait-a-while, *Calamus australis*. All notable stands of rain forest encountered were mapped and are shown in Fig. 1.

For the benefit of others planning to visit this area we add the following notes. Our investigations began at the point where the telegraph track crosses the river, from which point we travelled upstream. Canoes were chosen as the mode of transport, although prior to departure we were uncertain if such craft could negotiate the river. The Jardine is a large river and flows with quite a strong current. As no one had previously navigated its upper reaches we had no idea what problems might be encountered. As it turned out there were few real obstacles. The strong current caused the greatest hardship and produced some very weary canoeists. The first day we covered only 5 km. Thereafter we averaged approximately 10 km per day. We travelled constantly for eight days after which we reached a stand of "quality" rain forest about 1 km before the junction of the McHenry River. Here we established a base camp and later travelled upstream for another day to the next major junction. Beyond this point it was impossible to go further by canoe because many fallen trees completely spanned the stream. We had at this point travelled more than 80 km from the telegraph track crossing.

One of the more remarkable features of the river is its almost constant gradient. The river bed is white sand and the banks are sandy in nature. The only exceptions are two sets of rapids, the first some 53 km from the crossing and the second about 57 km. Both are formed principally from sandstone-like rock and can be negotiated with care. We were travelling during October (towards the end of the dry season) and the river level was comparatively low. Water depth averaged a little over 1 m near the crossing and about 0.3 m upstream. Extensive shallows were encountered and numerous submerged tree limbs were a constant hazard. The water was crystal clear but there was the occasional dark deep pool. One large crocodile (over 3 m long) was seen in such a pool. Crocodile tracks were seen elsewhere. Large catfish and the barrimundi, *Sclerophages jardini* were plentiful along the entire length of the river almost as far as the McHenry junction, but especially so below the rapids.

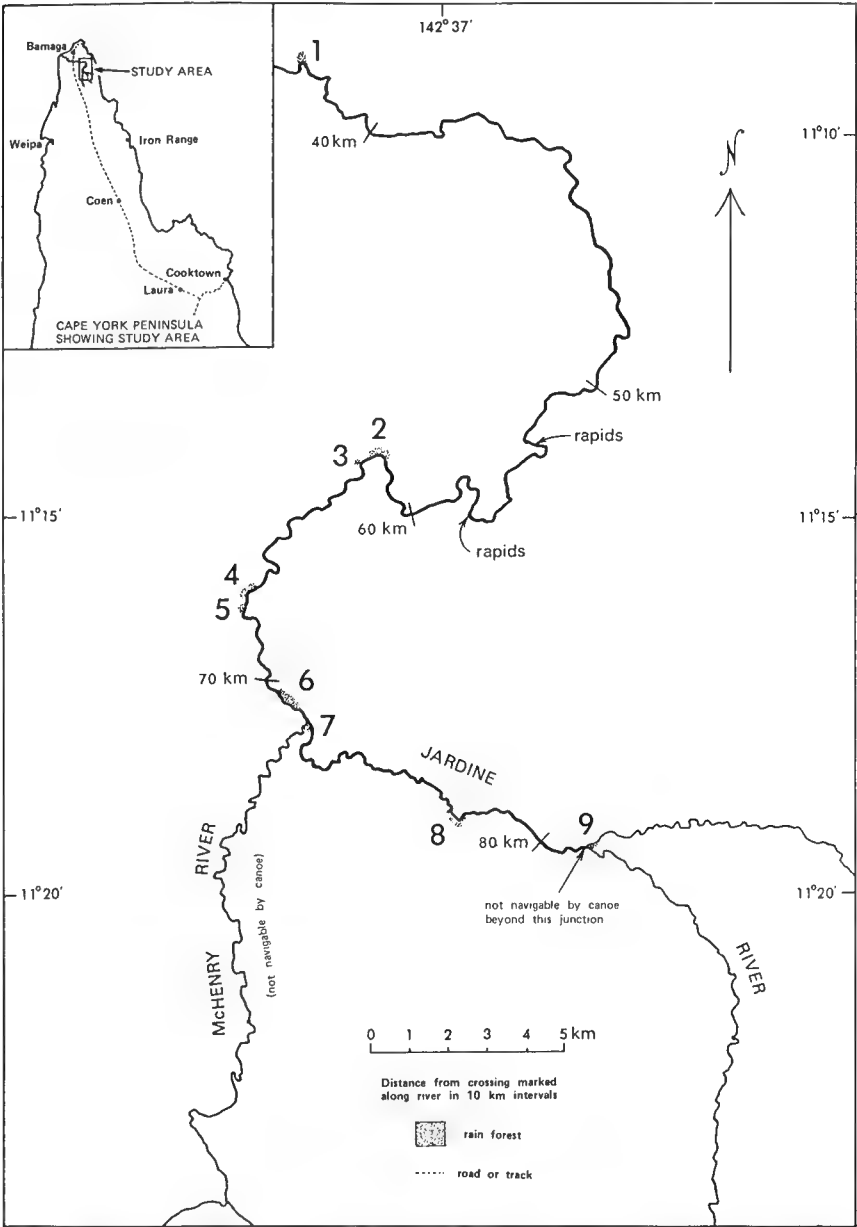


Fig. 1. Map of the upper Jardine River showing rain forest areas (numbered for reference 1-9).

List of species

All records, October, 1978. Rain forest areas referred to below by numerals are those shown in Fig. 1.

Species	Comments
HESPERIIDAE	
<i>Tagiades japetus janetta</i> Butler	Very common
<i>Toxidia inornata inornata</i> (Butler)	One specimen only. Previously recorded as far north as Shelburne Bay (Monteith and Hancock, 1977).
<i>Telicota eurotas laconia</i> Waterhouse	Three specimens taken on the northern side of the crossing amongst <i>Gahnia</i> . Two others taken in a small <i>Gahnia</i> swamp on the southern bank below rain forest area 1 at 142°33'E, 11°10'S. Previously unknown north of the Claudie River (Common and Waterhouse, 1981).
<i>Telicota mesoptis mesoptis</i> Lower	Very scarce
<i>Sabera caesina albifascia</i> (Miskin)	Plentiful
<i>Sabera dobboe autoleon</i> (Miskin)	Very scarce
PAPILIONIDAE	
<i>Papilio aegeus aegeus</i> Donovan	A few seen
<i>Papilio ulyssees joesa</i> Butler	Several seen at various locations along the upper portion of the river.
<i>Pachliopta polydorus queenslandicus</i> (Rothschild)	Scarce
PIERIDAE	
<i>Delias argenthona argenthona</i> (Fabricius)	Common
<i>Delias mysis waterhousei</i> Talbot	Common in most rain forest areas.
<i>Delias aruna inferna</i> Butler	Common only in rain forest areas 6 and 7. Two specimens sighted at area 1.
NYMPHALIDAE	
<i>Danaus affinis affinis</i> (Fabricius)	Uncommon
<i>Danaus hamatus hamatus</i> (W. S. Macleay)	Uncommon
<i>Euploea sylvester sylvester</i> (Fabricius)	Very common but only at one location a little below rain forest area 2.
<i>Tellervo zoilus gelo</i> Waterhouse and Lyell	Common only in rain forest area 7.
<i>Melanitis leda bankia</i> (Fabricius)	Uncommon
<i>Mycalesis terminus terminus</i> (Fabricius)	Uncommon
<i>Mycalesis perseus perseus</i> (Fabricius)	Uncommon
<i>Hypocysta irius</i> (Fabricius)	Uncommon
<i>Hypocysta adiante adiante</i> (Hübner)	Uncommon
<i>Xoia arctoa arctoa</i> (Fabricius)	Uncommon
<i>Neptis praslini staudingereana</i> Nicéville	Uncommon
<i>Pantoporia venilia moorei</i> (W. J. Macleay)	Uncommon
<i>Pantoporia consimilis consimilis</i> (Boisduval)	Uncommon
<i>Doleschallia bisaltide australis</i> C. & R. Felder	One specimen only
<i>Hypolimnastis bolina nerina</i> (Fabricius)	Very scarce

Species	Comments
<i>Hypolimnias alimena lamina</i> Fruhstorfer	Uncommon. One very melanic ♀ amongst material taken.
<i>Junonia hedonia zelima</i> (Fabricius)	Very scarce
<i>Junonia orithya albicincta</i> Butler	Very scarce
<i>Cupha prosopoe prosopoe</i> (Fabricius)	Uncommon
LYCAENIDAE	
<i>Pseudodipsas eone iole</i> Waterhouse & Lyell	One specimen only
<i>Philiris fulgens kurandae</i> Waterhouse	Uncommon. Found only at one location above the uppermost rapids. Previously recorded as far north as Shelburne Bay (Monteith and Hancock, 1977).
<i>Philiris innotata evinculis</i> Wind and Clench	One specimen only
<i>Arhopala micale amytis</i> (Hewitson)	Locally common
<i>Hypolycaena phorbas phorbas</i> (Fabricius)	Uncommon
<i>Deudorix epirus agimar</i> Fruhstorfer	One specimen taken in rain forest area 8.
<i>Candalides helenita helenita</i> (Semper)	Common
<i>Candalides geminus</i> Edwards and Kerr	Common
<i>Praetaxila segecia punctaria</i> (Fruhstorfer)	Five specimens from rain forest areas 2, 3, 6 and 7.

Discussion

Conditions at the time of our survey were rather dry which, no doubt, reduced the number of butterflies on the wing. Few specimens were seen outside of rain forest areas and consequently little was encountered along the lower half of the river travelled. The notable exception was *Telicota eurotas* taken in shaded situations at the telegraph crossing and a little further upstream.

The number of Hesperiidæ encountered was surprisingly low. Only six species were taken and four of these only in small numbers. Despite the numerous palms growing in the area no palm-feeding species was taken.

In contrast, Pieridæ were comparatively common. *Delias mysis* was plentiful and occurred in most areas of rain forest. *D. aruna* was plentiful until about 9 am each morning in rain forest area 6 (refer Fig. 1), where specimens flew high in a small clearing. Later each day several adults could always be found settled on leaf litter in rain forest area 7 at the junction of the Jardine and McHenry Rivers. When disturbed these specimens would usually fly a short distance and resettle. Both males and females adopted this behaviour. *D. argenthona* was less common but widespread.

The behaviour of the lycaenid *Praetaxila segecia* is also worthy of comment. Specimens were only found as isolated individuals settled amongst leaf litter within deeply shaded rain forest (areas 2, 3, 6 and 7 in Fig. 1).

Despite a constant search for *Ornithoptera priamus* (L.) none were sighted at any time during the three weeks we were in the area. This often common species was also absent from the list of 98 species given by Monteith and Hancock (1977) from the Shelburne Bay region which includes rain forest areas immediately to the east and south of the Jardine River catchment. There are no other known specimens from the region and the statement made by Haugum and Low (1978, p. 142) that "Scattered populations exist in the Jardine River valley forests . . ." is incorrect and based purely on assumption. Lavarack and Stanton (1977) do not record *Aristolochia*, the only food plant of *O. priamus*, from the region. Their paper, however, was not intended to be detailed in its listings. We therefore made an extensive search for this vine during our studies but it appeared to be entirely absent. These findings suggest that *O. priamus* is either permanently absent from this region or occurs only on rare occasions. If this is so the geographical isolation of subspecies *macalpinei* Moulds is indeed real and the unique characters displayed by the adult confirm its subspecific status despite doubts expressed by D'Abrera (1976) and Haugum and Low (1978).

Our observations of the habitats encountered along the upper Jardine leave us no doubt that the region must carry a rich insect fauna. A survey at a more favourable time of year should prove most rewarding. It appears that the butterfly fauna somewhat parallels that of the nearby Shelburne Bay region as listed by Monteith and Hancock (1977). Only two species, *Telicota eurotas* and *Euploea sylvester*, remain unlisted by them. They, however, remarked on the apparent absence of *Euploea* during their survey (they took only *E. core*) and it would not be unreasonable to assume that all five *Euploea* species known to range widely on Cape York Peninsula occur both in the Shelburne Bay region and along the upper Jardine River.

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DIRHINUS RUFRICORNIS (GIRAULT) (HYMENOPTERA: CHALCIDAE: DIRHININAE), A PARASITE OF DIPTERA, TWO OF WHICH ARE PRIMARY PARASITES OF ORTHOPTERA

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Abstract

Dirhinus ruficornis (Girault) (Hymenoptera: Chalcididae) is recorded as a parasite of *Ceracia fergusoni* (Malloch) (Diptera: Tachinidae) and *Blaesoxipha pachytyli* (Skuse) (Diptera: Sarcophagidae), both of the latter being primary parasites of the Australian plague locust, *Chortoicetes terminifera* (Walker) and other acridids.

The duration of life history stages of *D. ruficornis* in the laboratory with *Lucilia cuprina* (Wiedemann) (Diptera: Calliphoridae) as host was: egg 3 days, larva 7 days, pupa 12 days. Females parasitised an average of 2.1 host pupae per day. The longevity of females ranged from 17-32 days and males 13-91 days.

Introduction

Girault (1915) gave data on the distribution of *Dirhinus ruficornis* (Girault) (as *D. sarcophagae*) in northern Australia. Froggatt (1919) records the sarcophagid *Parasarcophaga aurifrons* (Macquart) as a host, while Wilson (1960) records the sarcophagids *Boettcherisca peregrina* (Rob. Desvoidy) (= *Sarcophaga irrequieta* Walker), *Tricholioproctia* (= *Sarcophaga*) *impatiens* (Walker), and the calliphorids *Calliphora villosa* (= *stygia*) (Fabricius), *Chrysomya rufifacies* (Macquart), *Chrysomya varipes* (Macquart) and *Lucilia sericata* (Meigen). In this study *D. ruficornis* was reared from the puparia of *Blaesoxipha pachytyli* (Skuse) (Sarcophagidae) and *Ceracia fergusoni* (Malloch) (Tachinidae) obtained from field collected adults of the Australian plague locust, *Chortoicetes terminifera* (Walker). *D. ruficornis* were cultured in the laboratory in *Lucilia cuprina* (Wiedemann) (Calliphoridae) puparia and some biological data recorded. The study was limited due to the onset of haploid reproduction a short time after the commencement of the laboratory culture.

Method

On 7 January, 1978, *C. terminifera* adults were collected with a sweep net from a swarm at Yalgogrin in the eastern Riverina District, New South Wales and retained in a sealed calico bag. Five days later (12 January, 1978) the larvae of two species of dipterous parasites emerged from the *C. terminifera* adults and were removed from the bag and placed in screw top jars to pupate. From five *C. fergusoni* puparia thus obtained, one adult *C. fergusoni* emerged on 22 January, 1978 and parasitic wasps of the species *D. ruficornis* (1 ♂, 2 ♀) emerged from three others on 30 January, 1978 (23 days after collection of the *C. terminifera* and 8 days after emergence of the adult *C. fergusoni*), while the fifth puparium failed to develop. From 13 *B. pachytyli* puparia also obtained from the *C. terminifera*, five adult *B. pachytyli* emerged between 24-27 January, 1978 and two male *D. ruficornis* emerged on 31 January, 1978 (24 days after collection, and 4-7 days after the emergence of the adult *B. pachytyli*). Six puparia failed to develop.

The two female and one male *D. rufigornis* adults (from *C. fergusonii* puparia) were placed with 40 *L. cuprina* puparia on 7 February, 1978. Only two female *D. rufigornis* were bred (emerging on 27 February, 1978), the remaining puparia giving rise to *L. cuprina* (4) or *Alysia manducator* (Panzer) (Braconidae) (34), which had parasitised the *L. cuprina* puparia prior to their placement with the *D. rufigornis*. Using these two unmated female *D. rufigornis* a further generation was reared, all males.

During breeding, each *D. rufigornis* was held in a 200 x 40 mm glass vial with brass gauze stopper. A 10% sugar solution soaked into cotton wool pads was replenished every third day. Female *D. rufigornis* were provided with 10-25 *L. cuprina* puparia each one to three days, depending on the availability of *L. cuprina* puparia. These puparia, once replaced, were retained in identical containers. A sample of three to five puparia was dissected for each day after placement up to day 21 (in all 51 puparia) and the incubent life history stages of *D. rufigornis* measured and mounted on slides using Hoyer's mounting medium. The laboratory rearing was conducted at a mean temperature of 22.4°C (mean max. 25.7°C; mean min. 19.0°C).

Results

Oviposition: *D. rufigornis* oviposited in *L. cuprina* puparia of age six to seven days (Fig. 1; 3.iii.78) and one to two days (Fig. 1; 6.iii.78). The pupal period of *L. cuprina*, under the experimental conditions, was eight to ten days, indicating a wide range in age of puparia susceptible to parasitism. Greathead (1959) found parasitism of *Stomorphina lunata* (F.) by *Dirhinus excavatus* Dalman increased with time, indicating parasitism occurred throughout the pupal stage.

Fecundity: The average number of host puparia parasitised per day was 2.17 for female 1 (37 in 17 days) and 2.03 for female 2 (65 in 32 days). No puparia were parasitised in the first two days following emergence. The number parasitised increased to a maximum of six at age eight days after which there was a decline to approximately three per day (Fig. 2).

The number of host puparia provided was not a limiting factor in the assessment of fecundity. Only 44.5% of puparia provided to female 1 were parasitised and 25.3% of those provided to female 2 (83 and 256 respectively).

Only a single adult emerged from each parasitised puparium and during dissection only one specimen was found in each puparium.

Longevity: The mean longevity of males provided with sucrose solution replenished every third day was 38.35 days (range 13-91; n = 31); supplied with water 10.0 days (range 7-11; n = 10); unfed 9.66 days (range 6-11; n = 6). Two females lived for 17 and 32 days.

Description and duration of developmental stages

The duration of development from oviposition to adult emergence ranged from 21-29 days (mean 22.78, n = 51). Development was independent of the stage of development of the host when parasitised. As a result the interval between emergence of adult hosts from unparasitised puparia and

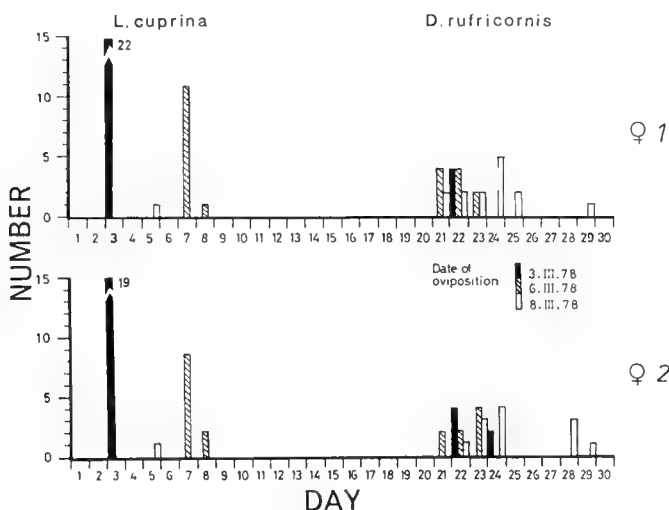


Fig. 1. Time of emergence after oviposition by *D. rufigicornis* of *L. cuprina* adults from unparasitised puparia and *D. rufigicornis* adults from parasitised puparia.

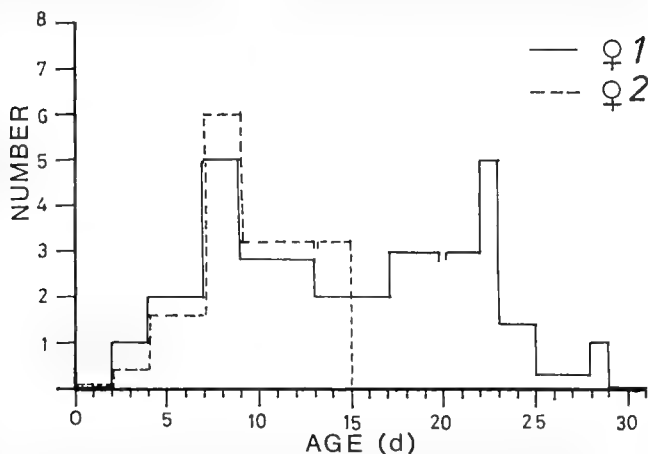
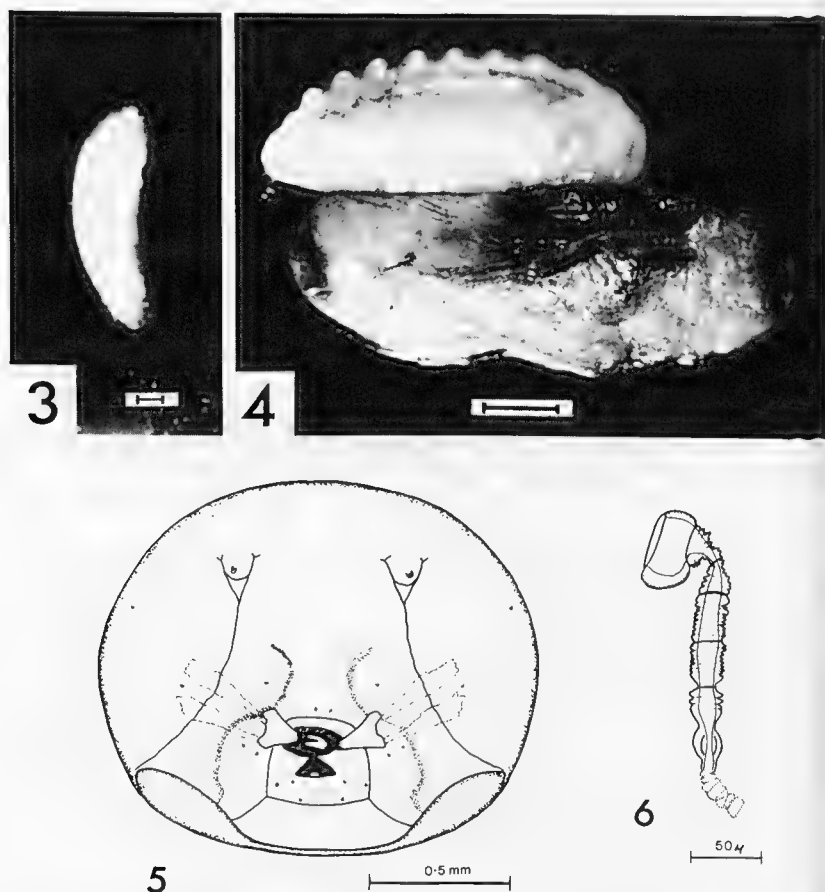


Fig. 2. The number of *L. cuprina* puparia parasitised per day by two *D. rufigicornis* females (number averaged over periods of 1-3 days depending on the interval at which host puparia placed and removed). Female 1 died on day 17 and female 2 on day 32.

the emergence of the first *D. rufigicornis* from parasitised puparia was variable and ranged from 13-18 days (Fig. 1).

Egg (Fig. 3). 0.720-0.82 mm long, 0.15-0.27 mm in diameter; white; smooth; elongate; slightly concave on one side; ends rounded, slightly narrowed caudally. The period from oviposition to hatching is 3 days. All eggs were found in the fluid filled cavity surrounding the developing host pupa.



Figs 3-6. Developmental stages of *D. ruficornis*: (3) egg (scale = 0.1 mm); (4) fully developed larva feeding on host pupa (casing of puparium removed) (scale = 1.0 mm); (5) anterior view of head of final instar larva; (6) mesothoracic spiracle of final instar larva.

Final instar larva (Figs 4-6). Head hemispherical, lightly sclerotised; antennae a pair of low cones 13.4 μm in diameter; mandibles triangular with single, heavily sclerotised, apical tooth, articulating with pleurostoma dorsally and hypostoma ventrally; mouthparts in depression overhung by clypeus dorsally; maxillae two lateral projections above the mandibles, poorly differentiated; labium differentiated into long narrow prelabium and long narrow postlabium expanded laterally; tentorium two dark rods, apically supporting base of mandibles: thoracic segments (3), abdominal segments (10), without conspicuous setae: spiracles on meso and meta thorax and first seven abdominal segments, aperture round 34.5 μm in diameter surrounded by

transparent ring 48 μm in diameter, above cup-shaped swelling and conical tube constricted at base to 8.9 μm beyond which it is expanded to 21 μm before connecting to closing apparatus and hence trachea. The larval morphology of *D. rufricornis* compares well with previous descriptions of *Dirhinus* (Greathead 1959). In *D. excavatus* the spiracle apertures are not cup shaped above a constricted base as they are in *D. rufricornis*.

Larval development of males was complete in seven to eight days ($n = 17$) after hatching (10 days after oviposition).

Pupa. White, becoming black with development of adult colouration; morphology typical of Dirhininae; head pointed apically; hind femur distinctly swollen.

The duration of the pupal stage is 12 days ($n = 30$) at a mean temperature of 22.4°C. The eyes become pigmented 6 days after pupation. After eight days the entire pupa is black and at 11 days the pupa is fully developed with functional appendages. The fully developed adult emerges by forcing open the puparium along its line of weakness at the anterior end. This mode of emergence is similar to that of adult hosts from unparasitised puparia.

Discussion

D. rufricornis is not a hyperparasite because it attacks the primary parasite after it has left its hosts and this makes the circumstances of the initial record of *D. rufricornis* from primary parasites of *C. terminifera* unusual. It must be assumed that a fertile *D. rufricornis* female was taken on the wing at the time the *C. terminifera* collection was made and that parasitism of *C. fergusonii* and *B. pachytyli* took place subsequent to their emergence from *C. terminifera*. There is a possibility that the adult *D. rufricornis* was phoretic on adult *C. terminifera* or otherwise associated with the *C. terminifera* swarm. It would be extremely difficult to ascertain the significance of *D. rufricornis* as a parasite of the primary parasites of *C. terminifera* in the field. To obtain a sample of host puparia would involve an inordinate amount of searching over a short time interval given densities of less than one per 5 m² in areas occupied by swarms. The role of parasites of biological control agents of acridids has only been assessed for those which are hyperparasites or whose host is predacious on locust eggs enabling sampling in a concentrated area, for example *D. excavatus* (Greathead 1959) and *Dirhinus anthracina* Walker (Baker, unpublished data).

The only previous records of parasites of the biological control agents of acridids in Australia involve hyperparasites (Blackith 1967, Allsopp 1978, Baker and Pigott 1979). In other countries only two authors, Kelly (1914) and Spencer (1958), have recorded parasites of Diptera parasitic on the post-embryonic stages of acridids, though hyperparasites have been frequently recorded (Greathead 1963). The greater number of records of hyperparasites is not necessarily a reflection of their relative importance in the field. Hyperparasites are readily obtained when primary parasites are reared from field collected hosts (a common procedure) while parasites of parasitic Diptera

are only obtained after retention of field collected host puparia (an uncommon procedure).

D. rufricornis has a wide host range (Calliphoridae, Sarcophagidae, Tachinidae), including both non-parasitic Diptera (*L. cuprina*, *P. aurifrons*) and parasitic Diptera (*C. fergusonii*, *B. pachytyli*). A wide host range is characteristic of many species of chalcids and must limit their usefulness as biological control agents. There is a distinct danger that chalcids introduced to control a dipterous pest may adapt to indigenous parasitic Diptera, reducing the effectiveness of the latter. This is of particular concern in regions such as Australasia, North America and Africa where Diptera are the principal biological control agents of locusts (Baker 1979, Rees 1973, Greathead 1963).

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A NEW SPECIES OF *AMBLYSEIUS* BERLESE FROM THE NEW HEBRIDES WITH NOTES ON CLOSELY RELATED SPECIES FROM AUSTRALIA, JAPAN AND CHINA (ACARI: PHYTOSEIIDAE)

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Rydalmere, N.S.W., 2116

Abstract

Amblyseius sigridae sp. n. from *Artocarpus incisus* L. (Moraceae) in the New Hebrides is compared with *A. markwelli* Schicha from Australia, *A. okinawanus* Ehara from Japan, and specimens from China tentatively ascribed to *A. okinawanus*.

Introduction

Three closely related species of *Amblyseius* Berlese from Australia and the Orient are compared.

Depositories are abbreviated: BCRI Biological and Chemical Research Institute, Rydalmere; ZIFS Zoological Institute, Faculty of Science, Hokkaido University, Sapporo.

All measurements are in micrometres.

Genus *Amblyseius* Berlese

Amblyseius Berlese, 1914: 143. Type species by original designation: *Zercon obtusus* Koch, 1839.

Amblyseius sigridae sp. n.

(Figs 1-8)

Types:— NEW HEBRIDES: *Holotype* ♀, on *Artocarpus incisus* L. (Moraceae), Santo, 16.iv.1977, J. Gutierrez. (In BCRI).

FEMALE

Dorsum. Dorsal shield 291 long (D1-D6), 156 wide (L4-L4), reticulated laterally, with 17 pairs of setae, six dorsal, two median, four prolateral, five postlateral: D1 15, D2 to D4 8, D5 12, D6 9, M1 8, M2 28, L1 8, L2 and L3 10, L4 13, L5 10, L6 and L7 12, L8 13, L9 65. M2 and L9 slightly serrated, all other setae smooth. All setae shorter than distances between their bases and bases of setae following next in series. Seven pairs of large pores and six pairs of small pores. S1 12 on interscutal membrane, S2 7 on interscutal membrane on one side and on dorsal shield on opposite side. Peritremes extending forward beyond D1 (Fig. 1).

Venter. Sternal shield 51 long, 60 wide, with three pairs of setae and two pairs of pores. Fourth pair of setae and third pair of pores on small metasternal shields (Fig. 2). Pentagonal ventrianal shield 114 long, 90 wide, with three pairs of short preanal setae and a pair of oval preanal pores 24 apart, surrounded by three pairs of setae, three pairs of small shields, primary metapodal shield 18 long, secondary metapodal shield 12, and one pair of ventrocaudal setae 22 (Fig. 3).

Chelicera. Details difficult to see.

Spermatheca. Sack-like cervix 15-17 long; atrium occupying whole width of cervix where cervix fuses with major duct (Fig. 4).

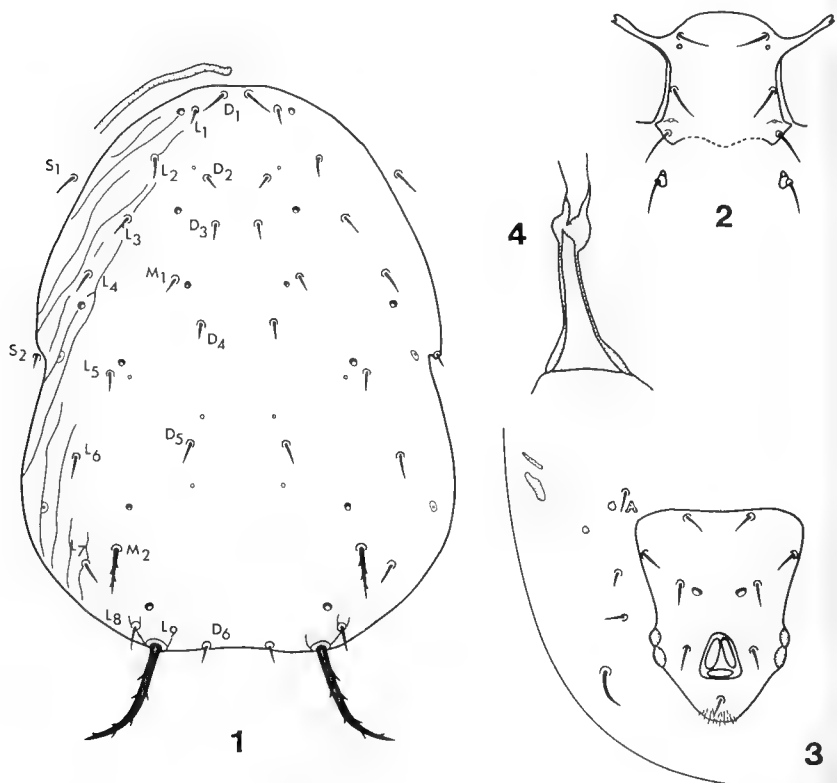
Legs. Eight macrosetae: small and blunt on femur I 7, knobbed on genu I 5 (Fig. 5), minute and blunt on genu II 5 (Fig. 6) and genu III 12, setaceous on tibia III 14 (Fig. 7), blunt on genu IV 23, setaceous on tibia IV 18 and basitarsus IV 39 (Fig. 8).

Amblyseius markwelli Schicha

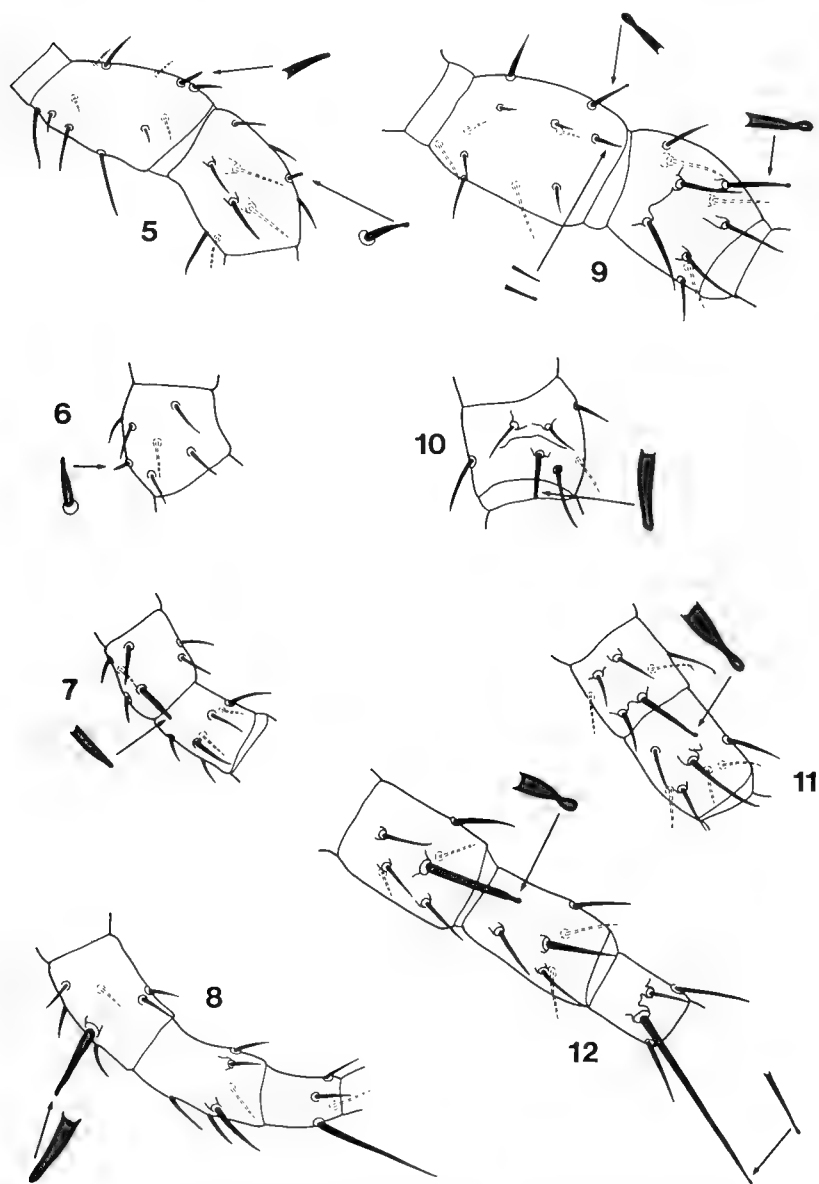
(Figs 9-16)

Amblyseius markwelli Schicha, 1979: 46.

Material examined:— QUEENSLAND: *Holotype* ♀ and nine *paratypes* as designated in Schicha (1979). NEW SOUTH WALES: Two ♀♀ and two ♂♂, on unidentified weeds, Bellingen, 29.iv.1980, E. Schicha. (All in BCRI).



Figs 1-4. *Amblyseius sigridae* sp. n. female: (1) dorsum; (2) sternal shield; (3) ventrianal shield; (4) spermatheca.



Figs 5-12. Leg setation of *Amblyseius sigridae* sp. n. (5-8), compared with that of *Amblyseius markwelli* (9-12). (5, 9) femur I - genu I; (6, 10) genu II; (7-11) genu III - tibia III; (8, 12) genu - basitarsus IV.

Add to original description:—

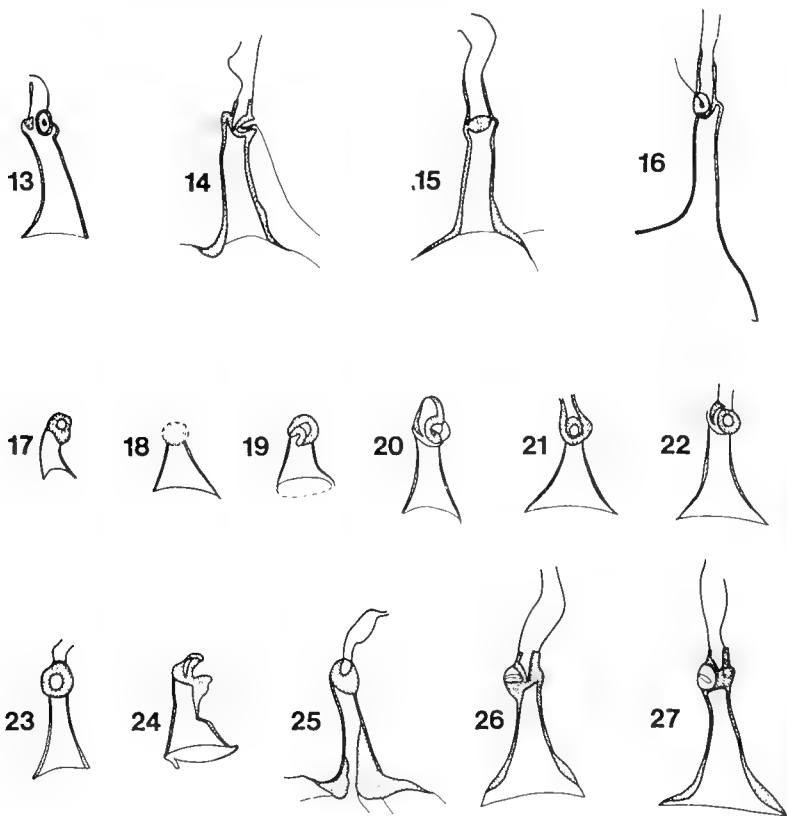
FEMALE

Dorsum. One pair of large pores near L4 and three pairs of small pores near D2, L5 and S2 (similar to *A. sigridae*, Fig. 1).

Chelicera. Fixed digit with 8-10 teeth (8—one observation; 9—five observations; 10—one observation); movable digit with 2-3 teeth (2—three observations; 3—four observations).

Spermatheca. Variable in slide-mounted type material (Figs 13-16).

Legs. Eight macrosetae: knobbed (9 observations, no exceptions) on femur I 9-12 long (9 measurements) and genu I 16-19 (Fig. 9), blunt on genu II 11-13 (Fig. 10), knobbed on genu III 14-20, setaceous on tibia III 14-17 (Fig. 11), knobbed on genu IV 24-28, setaceous on tibia IV 18-20, slightly knobbed on basitarsus IV 44-48 (Fig. 12).



Figs 13-27. Variations in spermathecae: (13-16) *Amblyseius markwelli*; (17-22) three paratype females of *A. okinawanus*; (23-27) three specimens from China ascribed to *A. okinawanus*.

***Amblyseius okinawanus* Ehara**

(Figs 28-32)

Amblyseius (*Amblyseius*) *okinawanus* Ehara, 1967: 72; Ehara and Lee, 1971: 64.

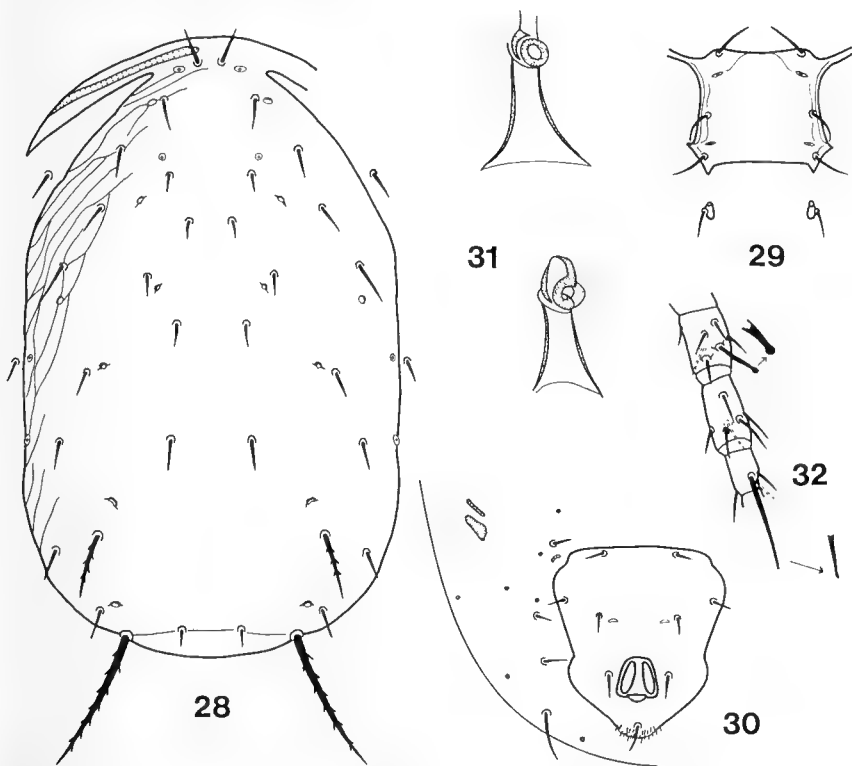
Material examined:— JAPAN: Three ♀♀ paratypes labelled "*Verbena officinalis*, Tomigusuku, Okinawa I., 22.iv.1966, Ehara *et al.*" (In ZIFS). CHINA: Three ♀♀ labelled "*Amblyseius okinawanus* Ehara" on citrus, Guangdong Province (other particulars in Chinese). (In BCRI).

Add to description by Ehara (1967) and Ehara and Lee (1971):—

FEMALE

Dorsum. Dorsal shield 314 long (D1-D6), 173 wide (L4-L4). Seven pairs of large pores and four pairs of small pores as figured (Fig. 28).

Venter. Sternal shield 57 long, 65 wide (Fig. 29). Pentagonal ventrianal shield 115 long, 92 wide, with a pair of oval preanal pores 22 apart, surrounded by eight pairs of small shields, primary metapodal shield 18 long, secondary metapodal shield 10 (Fig. 30).



Figs 28-32. *Amblyseius okinawanus*, from three paratype females: (28) dorsum; (29) sternal shield; (30) ventrianal shield; (31) spermatheca; (32) genu — basis-tarsus IV.

Spermatheca. Cervix 8 long, atrium bulbous (Fig. 31). Variable in slide-mounted specimens (Figs 17-22).

Legs. Seven macrosetae: knobbed on genu I 19-20, genu II 15-16 and genu III 21-23, setaceous on tibia III 18, knobbed on genu IV 31, setaceous on tibia IV 25, slightly knobbed on basitarsus IV 55 (Fig. 32).

NOTES

A. markwelli is more closely related to *A. okinawanus* than to *A. oguroi* Ehara, *A. asiaticus* (Evans), *A. reptans* Blommers or *A. daturae* Gupta, the species with which it was compared in Schicha (1979) (see notes on *A. okinawanus* below). It seems to prefer low herbaceous plants to shrubs and has not been found on any crop plant in Australia.

The measurements of *A. okinawanus* made by Ehara (1967) are confirmed. *A. okinawanus* differs from *A. markwelli* in (1) the slightly longer setae L4 and all macrosetae on legs II to IV; (2) the much shorter metapodal shields; (3) the shorter ($\times 0.5$) cervix and differently shaped spermatheca (Figs 17-22); and (4) the absence of a knobbed macroseta on femur I.

The females from China are very close to *A. okinawanus* and *A. markwelli* in most of their qualitative and quantitative features and somewhat intermediate between the two species in the size and shape of their spermathecae (Figs 23-27). In the absence of further information the specimens are ascribed to *A. okinawanus*.

A. sigridae is not obviously different from *A. markwelli* and *A. okinawanus* if only qualitative morphological characteristics of their dorsal and ventral shields, spermathecae, and legs IV are compared (details of chelicerae in *A. sigridae* difficult to see). However, *A. sigridae* is distinct from the above in (1) the much smaller dorsal shield; (2) the shorter setae D1, M2, L2 to L9, S1, S2 and macrosetae on genu III, tibia III, genu IV, tibia IV and basitarsus IV; and (3) the much shorter setae L1, and macrosetae on femur I, genu I and genu II.

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I thank Dr J. Gutierrez, Office de la Recherche Scientifique et Technique Outre-Mer, Noumea, for the new species; Prof. S. Ehara, Biological Institute, Tottori University, for the loan of females of *A. okinawanus*; and Dr Wu Wei-nan, Kwangtung Entomological Institute, Canton, for females labelled *A. okinawanus*.

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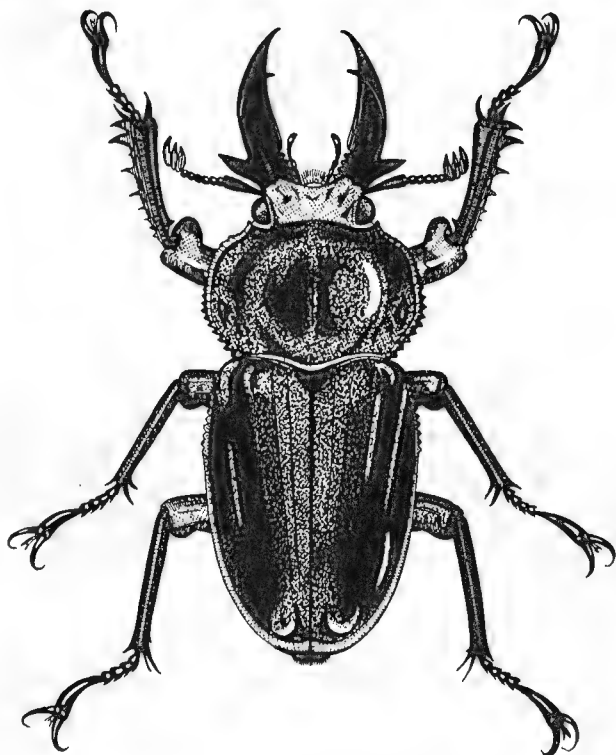
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COVER

Illustrated by B. L. Brunet

The large and beautiful stag beetle, *Phalacrognathus muelleri* Macleay (family Lucanidae), is one of Australia's most spectacular beetles. The dominant pigmentation is maroon and green with a brilliant mirror-like sheen. Large males can measure 60 mm or more in length. The species is found only in rain forest in north-eastern Queensland where the larvae feed in decaying logs. Adults fly at dusk and rarely venture beyond rain forest margins.

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THREE RECENT RECORDS OF *HYPOLIMNAS MISIPPUS* (L.) (LEPIDOPTERA: NYMPHALIDAE) FROM THE NORTH COAST OF NEW SOUTH WALES

J. and D. Brown

4 McDonnell Avenue, Cundletown, N.S.W. 2430

Within Australia, *Hypolimnas misippus* is distributed from north-western Australia, in an easterly arc to New South Wales. However, it has only occasionally been recorded from New South Wales (Common and Waterhouse 1981).

The female superficially resembles both *Danaus genutia alexis* (Waterhouse and Lyell) and *D. chrysippus petilia* (Stoll) while the male is similar to that of *Hypolimnas bolina nerina* (F.).

On 8th April 1981 one male of *H. misippus* was taken by us at a roadside grassed area immediately south of Kempsey on the central coast of New South Wales and a further male was later taken at Forster, over 130 km to the south, on 8th May 1981 from a vacant block within a residential area. A single female was collected at Cundletown, near Taree, on 2nd June 1981 from lantana blossom growing on a river bank.

Of possible significance was the occurrence of NE winds over periods within which these specimens were taken. Individuals may have been transported southwards by airflow from areas in which this species is more commonly encountered to the north.

Acknowledgement

We would like to thank Mr Geoff Williams for his assistance in drafting this note.

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A SURVEY OF THE APHODIINAE, HYBOSORINAE AND SCARABAEINAE (COLEOPTERA: SCARABAEIDAE) FROM SMALL WET FORESTS OF COASTAL NEW SOUTH WALES. PART 1: NOWRA TO NEWCASTLE

By G. A. Williams and T. Williams

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Abstract

Records of Aphodiinae, Hybosorinae and Scarabaeinae taken at spatially-limited wet forests between Nowra and Newcastle on the New South Wales coast are listed. Data include dates of collection, numbers of individuals encountered, bait types or collection method used, vegetation type, soil type and groundcover.

Introduction

This paper records results from a survey of small wet forest sites between Nowra and Newcastle on the New South Wales central coast; and represents part of a larger study of such habitats between Nowra and the Queensland border.

Recent revisions of the Australian Scarabaeinae by Matthews (1972, 1974 and 1976) provide a reliable framework for the determination of native species. The revisions also indicate a basic correlation of the fauna with vegetation and soil types and provides a distributional "over-view" of the fauna from surveys of major sclerophyll forests and rainforests of the eastern coast (Matthews *loc. cit.*). In general, spatially-limited wet forests of the central and northern New South Wales coast have been excluded from Matthew's distributions.

We were interested in establishing a faunal inventory of these sites to provide some insight into their possible role as species refuges and corridors of dispersal between more extensive areas of similar vegetation. Hybosorinae and Aphodiinae were included as they form, with the Scarabaeinae, a group which can be basically perceived as constituting complementary elements within the decomposer fauna of wet forest systems. We confined our attention to gully rainforest, small escarpment and summit stands of rainforest and wet sclerophyll forest and remnant tracts remaining after extensive land clearing. Larger wet forest tracts were included where these did not appear to have been recorded in Matthews (1972, 1974, 1976). The area under study contains a considerable number of small wet forests, mostly with a southern or south-eastern aspect, encompassed by drier sclerophyll forest as well as small patches of rainforest remaining after the clearing of the "Illawarra" and "Big Scrub" rainforests in the latter part of the 19th century.

Baited pit traps (Williams 1979) were placed at each site; normally three per visit. Not all members of the three subfamilies are attracted to excrement baits and so at some locations light trapping, litter sifting and observation of carrion and animal droppings, if present, were undertaken.

A map of study sites is given in Figure 1. Descriptions of site vegetation, soil type, ground coverage (leaf litter, ferns etc.), and distances, in a straight line, from Sydney are given in Table 1. A summary to species encountered is given in Table 2.

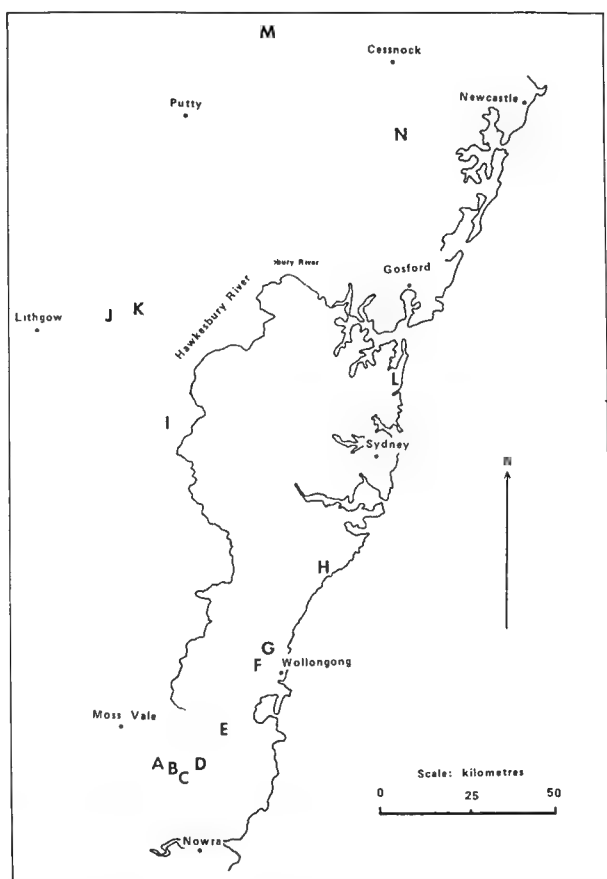


Fig. 1. Map of study sites: (A) Fitzroy Falls; (B) summit of Barrengarry Mountain; (C) eastern slope of Barrengarry Mountain; (D) upper Kangaroo Valley; (E) Macquarie Pass; (F) summit of Mt. Keira; (G) junction of Mt. Keira and Mt. Ousley roads; (H) Royal National Park; (I) Sassafras Gully; (J) Mt. Wilson; (K) Mt. Irvine; (L) Church Point, Ku-ring-gai Chase National Park; (M) Terrys Ck, Putty Rd; (N) Watagan State Forest, Bangalow Rd.

TABLE 1

List of study sites and species taken at each. Dates of collection are followed by figures in parenthesis indicating the number of specimens taken.

A. Fitzroy Falls, 110 km SW of Sydney between Nowra and Moss Vale. Gully restricted rainforest surrounded by low sclerophyll forest, dark brown loam soil.

Aphodius sp. 1.—13.i.1977, (1), under bird droppings. Voucher specimen from study site C in A.N.I.C.

B. Summit of Barrengarry Mountain, 115 km SW of Sydney between Nowra and Moss Vale. *Syncarpia* dominated wet sclerophyll forest, open grass and shrub cover, loam soil.

Aulacopris reichei White.—30.i.1978, (1), at faeces, a light was also operating on this night.

Lepanus illawarrensis Matthews.—18.ii.1978, (3), at faeces.

Onthophagus macrocephalus Kirby.—31.xii.1978, (1); 30.i.1978, (1), at faeces.

Onthophagus nurubuan Matthews?—18.ii.1978, (1), at faeces.

Onthophagus sydneyensis Blackburn.—31.xii.1978, (2); 30.i.1978, (1), at faeces.

C. Eastern slope of Barrengaray Mountain, 115 km SW of Sydney. Escarpment rainforest, open forest floor, heavy rock and leaf litter cover, shallow brown loam soil.
Aphodius tasmaniae Hope.—29.i.1977, (6), at light.

Aphodius sp. 1.—29.i.1977, (2), at faeces. Voucher specimen in A.N.I.C.

Liparochrus sculptilis Westwood?—29.i.1977, (2); 31.xii.1977, (1); 30.i.1978, (1), at faeces.

Amphistomus speculifer Matthews.—13.i.1977, (5); 30.i.1977, (2); 30.i.1978, (3), at faeces and fresh chicken bones.

Aulacopris reichei White.—13.i.1977, (1), at faeces.

Lepanus bidentatus (Wilson).—13.i.1977, (2), at faeces.

Lepanus illawarrensis Matthews.—13.i.1977, (5); 30.i.1977, (3); 31.xii.1977, (8); 30.i.1978, (3); 27.i.1979, (5), at faeces.

Onthophagus longipes Paulian.—30.i.1977, (1); 31.xii.1977, (1), at faeces.

Onthophagus pugnax Harold.—29.i.1977, (3); 31.xii.1977, (1); 27.i.1979, (2), at faeces.

Onthophagus sydneyensis Blackburn.—13.i.1977, (2); 30.i.1977, (6); 31.xii.1977, (5); 30.i.1978, (3); 18.ii.1978, (3); 27.i.1979, (4), at faeces, mushrooms and fresh chicken bones.

D. Upper Kangaroo Valley below Yeola, 110 km SW of Sydney. Gully rainforest within dry sclerophyll forest, rocky loam soil.

Aphodius tasmaniae Hope.—6.i.1979, (37), at light, probably attracted mainly from adjoining dry sclerophyll forest.

Amphistomus speculifer Matthews.—6.i.1979, (3), at faeces.

Onthophagus auritus Erichson.—6.i.1979, (2), at faeces, trap set very close to adjoining sclerophyll forest.

E. Macquarie Pass, 90 km SW of Sydney between Robertson and Albion Park. Rainforest with *Livistona* palms dominating border, open fern floor coverage, loam soil.
Amphistomus speculifer Matthews.—30.ix.1979, (4), at faeces and fresh chicken bones.

F. Summit of Mount Keira via Wollongong, 70 km S of Sydney. Wet sclerophyll forest, heavy plant and bark coverage of forest floor, loam soil.

Lepanus bidentatus (Wilson).—25.xi.1978, (5), at faeces.

Lepanus illawarrensis Matthews.—25.xi.1978, (3), at faeces.

Onthophagus bornemisszai Matthews.—24.xi.1978, (1), under horse droppings in forest clearing.

Onthophagus hoplocerus Lea.—25.xi.1978, (6), at faeces.

Onthophagus sydneyensis Blackburn.—25.xi.1978, (3), at faeces.

G. Junction of Mount Keira and Mount Ousley roads via Wollongong, 65 km S of Sydney. Rainforest disturbed by tree felling and pedestrian access, open forest floor, dark brown loam soil.

Cephalodesmus armiger Westwood.—25.xi.1978, (7); 30.ix.1979, (9), at faeces.

Lepanus illawarrensis Matthews.—25.xi.1978, (3); 30.ix.1979, (6), at faeces.

Onthophagus hoplocerus Lea.—25.xi.1978, (6); 30.ix.1979, (3), at faeces.

Onthophagus sydneyensis Blackburn.—25.xi.1978, (5); 30.ix.1979, (3), at faeces.

Onthophagus waterhousei Boucomont & Gillet.—30.ix.1979, (2), at faeces.

H. Royal National Park (S section of Couranga Track), 35 km S of Sydney. Gully rainforest within *Eucalyptus* and *Syncarpia/Livistona* dominated sclerophyll forest, heavy leaf litter and sandy loam soil.

Liparochrus sculptilis Westwood?—16.xii.1979, (1), at faeces.

Amphistomus speculifer Matthews.—27.x.1979, (2); 11.xi.1979, (2); 16.xii.1979, (3), at faeces.

Cephalodesmus armiger Westwood.—25.xi.1978, (3); 27.x.1979, (2); 13.xi.1979, (3); 16.xii.1979, (4), at faeces, at times entering adjoining *Syncarpia/Livistona* forest.

Lepanus bidentatus (Wilson).—27.x.1979, (1), at faeces.

Lepanus sp. near *pisoniae* (Lea).—25.xi.1978, (3); 30.ix.1979, (6); 27.x.1979, (1); 16.xii.1979, (5), at faeces. This is an undescribed species (Matthews pers. comm.). Specimens deposited in A.N.I.C.

Onthophagus bornemisszai Matthews.—12.xi.1979, (4), at faeces on border of rainforest gully and adjoining *Syncarpia/Livistona* forest.

Onthophagus pugnax Harold.—13.xi.1979, (6); 16.xii.1979, (1), at faeces.

Onthophagus sydneyensis Blackburn.—13.xi.1979, (3); 16.xii.1979, (4), at faeces. Taken also in adjoining dry forest on 27.x.1979, (1), but not in rainforest on that occasion.

I. Sassafras Gully via Springwood, 60 km NW of Sydney. Very open gully rainforest surrounded by severely burnt dry sclerophyll forest, sandy loam soil. Specimens recorded only from trap set adjacent to creek, no specimens encountered at traps placed away from creek (greater than 20 m) nor at trap set on rainforest/burnt dry sclerophyll margin.

Liparochnus bimaculatus Westwood.—26.xii.1979, (3), at faeces.

Lepanus australis Matthews.—26.xii.1979, (6), at faeces.

Lepanus bidentatus (Wilson).—26.xii.1979, (1), at faeces.

Lepanus sp. near *pisoniae* (Lea).—26.xii.1979, (7), at faeces. This species is that similarly noted from Royal National Park. Voucher specimens in A.N.I.C.

J. Mt. Wilson, 85 km NW of Sydney (3 sites); (1) "Cathedral of Ferns"; summit rainforest with heavy fern groundcover disturbed in sections by free-ranging stock, brown sandy loam; (2) "Happy Valley"; escarpment rainforest adjoining wet sclerophyll forest, open forest floor, dark loam soil; (3) "Zircon Creek"; gully rainforest, light brown loam soil.

Aphodius tasmaniae Hope.—21.i.1978, (1), at faeces, though common at light in adjoining open-floored sclerophyll forest.

Aphodius sp. 2.—5.i.1980, (26), only at faeces baited pit traps left *in situ* for five days. Not taken during extensive overnight trapping. Voucher specimen in A.N.I.C.

Liparochnus bimaculatus Westwood.—4.xii.1977, (4); 19.xi.1978, (3); 21.i.1978, (3); 26.xii.1979, (4); 5.i.1980, (1), at faeces and entering adjoining wet sclerophyll forest.

Lepanus bidentatus (Wilson).—22.i.1978, (7); 30.xii.1979, (4); 5.i.1980, (2), at faeces.

Lepanus illawarrensis Matthews.—22.i.1978, (3), at faeces, nine traps were set on this occasion. 19.xi.1978, (52); 26.xii.1979, (18); 27.xii.1979, (16), at faeces on rainforest/sclerophyll forest border ("Happy Valley" section.); 30.xii.1979, (11); at faeces. Specimens deposited in A.N.I.C.

Onthophagus capella Kirby.—5.i.1980, (1), at faeces but common at light in adjoining sclerophyll forest.

Onthophagus macrocephalus Kirby.—19.xi.1978, (1); 30.xii.1979 (1), at faeces.

Onthophagus sydneyensis Blackburn.—19.xi.1978, (11); 3.xii.1977, (6); 30.xii.1979, (5); 22.i.1978, (4); 5.i.1980, (6), at faeces, also entering adjoining wet sclerophyll forest.

K. Mt. Irvine, 80 km NW of Sydney (2 sites): (1) 0.6 km SE of "Irvineholme" (750 m alt.), wet sclerophyll forest, heavy fern coverage, loam soil; (2) "Sassafras" (750 m alt.), rainforest with conspicuous lianes, bare forest floor, loam soil. Rainforest at this site noticeably distinct from that of Mt. Wilson.

1. Wet sclerophyll forest.

Liparochnus bimaculatus Westwood.—12.i.1980, (1), at faeces.

Amphistomus speculifer Matthews.—5.i.1980, (8); 12.i.1980, (15), at faeces.

Aptenocanthos rossi Matthews (det. Matthews & Weir).—5.i.1980, (1), at faeces, in a section of the site distinguished by closely spaced trees of uniform narrow trunk girth with a low canopy.

Lepanus australis Matthews.—5.i.1980, (2), at faeces.

Onthophagus capella Kirby.—12.i.1980, (5), at faeces.

Onthophagus macrocephalus Kirby.—12.i.1980, (2), at faeces.

Onthophagus sydneyensis Blackburn.—5.i.1980, (3); 12.i.1980, (7), at faeces.

2. Rainforest

Lepanus bidentatus (Wilson).—12.i.1980, (1), at faeces.

Onthophagus capella Kirby.—5.i.1980, (2); 12.i.1980, (7), at faeces.

Onthophagus sydneyensis Blackburn.—5.i.1980, (2), at faeces.

L. Church Point, Ku-ring-gai Chase National Park, 25 km N of Sydney. Gully rainforest adjoining residential areas, heavy *Livistona* palm-leaf litter, very rocky, sandy loam soil.

Lepanus australis Matthews.—17.xi.1979, (1), at faeces.

Lepanus bidentatus (Wilson).—17.xi.1979, (1), at faeces.

Onthophagus sydneyensis Blackburn.—17.xi.1979, (1), at faeces.

M. Terry's Creek, Putty Road, 120 km NNW of Sydney. Extremely small section of gully rainforest (c. 20 m x 70 m), restricted to the northern side of gully, within dry sclerophyll forest, sandy loam soil, heavy leaf litter groundcover, heavy predestrian disturbance.

Lepanus australis Matthews.—1.x.1978, (1), in leaf litter.

Onthophagus pugnax Harold.—1.x.1978, (2), at faeces.

N. Watagan State Forest (Bangalow Road), 100 km NNE of Sydney. Gully rainforest within drier sclerophyll forest, light fern and leaf litter groundcover, dark brown-grey clay loam soil.

Liparochnus bimaculatus Westwood?—1.xii.1979, (1), at faeces.

Amphistomus speculifer Matthews.—1.xii.1979, (4), at faeces.

Cephalodesmus armiger Westwood.—1.xii.1979, (3), at faeces.

Onthophagus bornemisszai Matthews.—1.xii.1979, (8), at faeces.

Onthophagus pugnax Harold.—1.xii.1979, (1), at faeces.

Onthophagus rubicundulus Macleay.—1.xii.1979, (2), at faeces.

Onthophagus sydneyensis Blackburn.—1.xii.1979, (9), at faeces.

TABLE 2

Summary of species by subfamily (letters indicate sites)

Family SCARABAEIDAE

Subfamily APHODIINAE

Aphodius tasmaniae Hope.—C, D, J.

Aphodius sp. 1.—A, C.

Aphodius sp. 2.—J.

Subfamily HYBOSORINAE

Liparochnus bimaculatus Westwood.—I, J, K (1).

L. bimaculatus Westwood?—N.

L. sculptilis Westwood?—C, H.

Subfamily SCARABAEINAE

Tribe ONTHOPHAGINI

Onthophagus capella Kirby.—J, K(1), K(2).

O. pugnax Harold.—C, H, M, N.

O. macrocephalus Kirby.—B, J, K(1).

O. hoplocerus Lea.—F, G.

O. nurubuan Matthews?—B.

O. auritus Erichson.—D.

O. longipes Paulian.—C.

O. waterhousei Boucomont & Gillet.—G.

O. sydneyensis Blackburn.—B, C, F, G, H, J, K(1), K(2), L, N.

O. rubicundulus Macleay.—N.

O. bornemisszai Matthews.—F, H, N.

Tribe SCARABAEINI

Aulacopris reichei White.—B, C.

Cephalodesmus armiger Westwood.—G, H, N.

Amphistomus speculifer Matthews.—C, D, E, H, K(1), N.

Aptenocanthon rossi Matthews.—K(1).

Lepanus bidentatus (Wilson).—C, F, H, I, K(1), K(2), L.

L. australis Matthews.—K(1), M.

L. sp. near pisoniae (Lea).—H, I.

L. illawarrensis Matthews.—B, C, F, G, J.

Discussion

Several distribution records of interest arose from this study. *Onthophagus rubicundulus* had previously been recorded by Williams (1979) at Harrington over 100 km further north but the species is more commonly known from the New South Wales-Queensland border (Matthews 1972).

Matthews (1974) records one specimen of *Lepanus illawarrensis* from Mt. Tamborine, in Queensland, but otherwise states that the species is restricted to the dense escarpment forest from Wollongong south to Clyde Mtn. Our records of this species from Mt. Wilson represent a north-western extension to its main range. To date, we have not collected *L. illawarrensis* from any of our study sites north of Mt. Wilson.

Records of *Lepanus australis* lessen the gap between those of Matthews (1974) from southern New South Wales (Macquarie Pass) and that of Williams (1979) from the lower north coast of New South Wales (Harrington). We have also encountered this species near Bouddi National Park (east of Gosford) during March in sclerophyll forest growing on badly drained soil. This is one of two Scarabaeini, the other being *Amphistomus speculifer*, from this study area which do not appear to be restricted to wet sclerophyll or rainforests.

Our single record of *Aptenocanthon rossi* from Mt. Irvine was especially interesting as the species was previously known only from the female holotype collected from the "vicinity of Mt. Wilson". Pit trapping by us over a number of seasons at Mt. Wilson failed to locate additional examples.

It is interesting to note the high ratio of Scarabaeini to Onthophagini encountered (Table 2), both in species numbers and numbers of individuals present. Excluding any Hybosorinae or Aphodiinae that may have been present, at no site did the Scarabaeini fall below 40% of the scarabaeine species and individuals encountered and frequently constituted 60-70%. At Sassafras Gully the Scarabaeini were the only scarabaeines present on the single sampling made sharing the site only with one species of Hybosorinae. This disproportionate representation is in marked contrast to the results of surveys by Allsopp (1975, 1977) in rainforest at Ravensbourne, south-east Queensland, where out of a total of eighteen species of dung beetles taken by him thirteen were Onthophagini (genus *Onthophagus*) and one Coprini (genus *Notopodaria*). The only *Onthophagus* ranging through most of our study sites was *O. sydneyensis* which also entered drier sclerophyll habitats.

Our species records from Macquarie Pass, Barrengarry Mountain and Mt. Keira are in accordance with those recorded by Matthews (1972, 1974) except for *Aulacopris reichei* which Matthews (1974) considered a rare species primarily associated with coastal *Casuarina* forest and sandy soil. Matthews (1974) does record *Lepanus politus* (Carter) from Macquarie Pass and Royal National Park, a species we have not encountered.

Our sampling experience has shown that spatially-limited wet forests are essentially "island-like" in regard to the dung beetle fauna found within them. We have found that such forest areas exhibit not only marked differences in the constitution of their faunas from adjoining habitats but also that differences can be expressed between the fauna of closely situated, but separated, wet forests. Of particular interest in this regard were our study sites at Mt. Wilson and Mt. Irvine. *Amphistomus speculifer* is a major element of the wet sclerophyll fauna at Mt. Irvine but was not encountered at Mt. Wilson. *Lepanus illawarrensis*, in contrast, dominated the wetter forest types at Mt. Wilson but was not trapped at Mt. Irvine.

We noted that low individual and species numbers in traps coincided with dry soil conditions within wet forests but to date we have not undertaken any definite measurements.

Although more extensive collecting may produce additional species records the list above (Table 1) demonstrates the impoverished nature of the region's fauna compared with that found further north along the eastern coast of Australia (c.f. Matthews 1972, 1974, 1976). However, the Scarabaeini are near their southern limit around the central coast of New South Wales and the Coprini have only one recorded representative, *Thyregis kershawi* Blackburn, found south of Taree.

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EGGS OF SOME TASMANIAN NOCTUIDAE (LEPIDOPTERA)

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Abstract

Morphological and biological data are presented for the eggs and oviposition behaviour of *Rictonis atra* (Guenée), *R. cyanoloma* (Lower), *R. microspila* (Lower), *R. ophiosema* (Turner), *R. tortisigna* (Walker), several undetermined *Rictonis* species, *Diarsia intermixta* (Guenée), *Peripyra sanguinipuncta* (Guenée), *Neumichtis sepultrix* (Guenée), *N. archephanes* Turner, *N. saliaris* (Guenée) and *Syntheta nigerrima* (Guenée).

Introduction

Since the revisions of the Tasmanian Lepidoptera by Turner (1925, 1938) very little has been recorded of the Tasmanian Noctuidae. The eggs of *Rictonis* Nye, *Neumichtis archephanes* Turner, *N. saliaris* (Guenée) and several minor pest species are discussed below as part of an ongoing study of the Tasmanian Noctuidae, particularly of the immature stages.

Rictonis is an objective replacement name for *Nitocris* Guenée (Nye, 1975) and is the largest noctuid genus in Tasmania. It is represented by around 20 species though none are of economic importance. Original descriptions of these species are inadequate and it is presently difficult to identify many species found in Tasmania. The male genitalia possess elongate tapering valvae bearing a single row of spines in the distal fifth and, with the claspers and aedeagus, provide no simple characters for specific differentiation. Exceptions are *R. leucosticta* (Turner) and *R. sp. near flexirana* (Walker) in which valva spines are absent. The larvae provide some useful specific characters including cuticle spicule size, head and body markings, and crochet formulae (Hill, unpub. thesis).

Methods

275 female Noctuidae representing 45 species were collected at a blended MV light and confined to glass jars covered with stretched muslin. Creased paper towel and greaseproof paper were added to provide four potential oviposition substrates viz. paper towel, greaseproof paper, glass walls and floor, and muslin. A potential fifth substrate in each jar was a small plastic vial containing a 2% sugar solution and paper wick.

Females were maintained at 18-22°C in an optionally heated laboratory exposed to natural light (February-March) plus an irregular amount of artificial light on many nights. In the same room all eggs were maintained on moist filter paper in petri dishes. Eggs were not surface sterilized and good hatching rates were obtained except for the eggs of hadenine species.

Because precapture oviposition histories of females were not known, data for fecundity and longevity of each species are presented as maxima observed as well as averages.

Eggs were measured in 80% ethanol plus 5% glycerol using a dissecting microscope and scaled eyepiece at x40. Diameters were measured and vertical ridges counted in dorsal view at the equator while heights of domed eggs were measured in lateral view from the micropyle to the circumference of the smooth base. Averages of vertical ridge numbers have been rounded to whole numbers. General observations of preserved eggs were made at x80. Fragments of chorion from preserved eggs were mounted in lactophenol on slides and measurements of aeropyle vestibules and ribbing made with a scaled eyepiece at x400. Scanning electron micrographs were obtained from a JEOL JXA 50A microscope using live eggs mounted to brass stubs and coated with a thin layer of gold over carbon in a JEOL JEE 4B vacuum evaporator.

The terminology of Salkeld (1973, 1975) is applied to the chorionic architecture but the term ribbing rather than reticulation is used to refer to well defined struts lying on the chorion surface, often along ridges of the chorion.

Material examined

Eggs obtained from the following specimens were examined along with slide preparations of chorion fragments from those asterisked. The numbers given are the author's unique specimen numbers attached to specimens. Unless otherwise stated specimens are deposited in the Tasmanian Agriculture Department Entomology Branch collection. Other depositories are ANIC Australian National Insect Collection and LH author's collection. All specimens were collected in southern Tasmania in 1979 and 1980. Eggs from specimens in bold type are deposited in ANIC. *Rictonis atra* (Guenée) 633* LH; *R. sp. near capularis* (Guenée) 635* LH, 636 LH; *R. sp. near cryphaea* (Turner) 61*; *R. cyanoloma* (Lower) 272, 273, 274*, 276; *R. sp. near flexirena* 36*, 650 LH, 651* LH; *R. microspila* (Lower) 18, 22, 29, 30, 39*, 66, 231, 257, 258, 293; *R. ophiocoma* (Turner) 228, 229*, 305, 369, 429, 630 LH, 637 LH, 638 LH; *R. tortisigna* (Walker) 108, 259, 260, 308*; *R. sp. 1* 277*; *R. sp. 3* 168*, 171, 174, 175, 307, 311; *R. sp. 7* 278*; *R. sp. 8* 309*; *R. sp. 9* 64*; *Peripyras sanguinipuncta* (Guenée) 20, 26, 27, 28, 50, 51*; *Diarsia intermixta* (Guenée) 23, 63, 163, 296, 299, 385, 510, 511*; *Syntheta nigerrima* (Guenée) 4, 582* ANIC; *Neumichtis sepultrix* (Guenée) 295, 297*; *N. saliaris* 16*, 492* ANIC; *N. archephanes* 1, 2, 3, 5* ANIC, 6.

Adult specimens reared from eggs of some of the preceding moths are deposited in the ANIC as follows: *R. atra* 1 ♀ ex 633; *R. sp. near capularis* 1 ♂ ex 635, 1 ♂ ex 636; *R. sp. near cryphaea* 1 ♀ ex 61; *R. cyanoloma* 1 ♂ ex 272; *R. microspila* 1 ♀ ex 39, 1 ♀ ex 258; *R. ophiocoma* 1 ♂ ex 305, 1 ♀, 1 ♂ ex 369; *R. tortisigna* 1 ♂ ex 260; *R. sp. 3* 1 ♂ ex 175; *N. sepultrix* 1 ♂ ex 297.

Results

Rictonis Nye (Figs 1-9)

Description of egg.— Domed; chorion with vertical ridges extending from outer margins of tertiary cells to circumference of large smooth flat base; vertical ridges bearing narrow longitudinal ribs 2-4 µm wide; horizontal ribs lying 20-30 µm apart linking vertical ribs, usually narrower than latter, their junctions with vertical ribs alternating along either side of latter; aeropyle vestibules 2-4 µm diameter, at junctions of vertical and horizontal ribs, extending entire length of vertical ridges; vertical ridges widening or not at aeropyle loci (e.g. *R. microspila* vertical ribs 2 µm wide, aeropyle vestibules 4 µm diameter, ribs widening conspicuously to 7 µm around aeropyle loci; *R. tortisigna* vertical ribs 2 µm wide, aeropyle vestibules 2 µm diameter, ribs barely widening around aeropyle loci; *R. cyanoloma* vertical ribs 2 µm wide, aeropyle vestibules 1 µm diameter, ribs not widening at aeropyle loci); columnar cell chorion varying from smooth (*R. microspila* and *R. tortisigna*) to gently reticulated (*R. ophiocoma*) at x1000 in scanning electron micrographs and appearing solid or very finely ringed in slide preparations at x400; micropylar rosette above level of secondary and tertiary cells, at same level as dorsal ends (shoulders) of vertical ridges. *R. sp. near flexirena* differing from the preceding as follows: columnar cell chorion granular; vertical ribs 5 µm wide; aeropyle vestibules 3 µm diameter; vertical ribs not widening at aeropyle loci. Table 1 lists vertical ridge number, height, diameter and colour sequence during incubation for eggs of 13 species.

TABLE 1

Rictonis egg dimensions and colour sequence through incubation; N—number of females providing eggs, n—number of eggs measured (sample sizes for vertical ridge counts are usually larger), c—cream, g—grey, r—red, p/c—pink dorsally and cream ventrally.

Species	Vertical ridges ave (range)	Height mm ave (range)	Diameter mm ave (range)	Colour sequence	N	n
<i>R. atra</i>	37 (33-40)	0.45 (0.43-0.47)	0.66 (0.65-0.67)	c, g	1	10
<i>R. nr. capularis</i>	38 (34-40)	0.56 (0.54-0.57)	0.66 (0.64-0.68)	c, g	2	20
<i>R. nr. cryphaea</i>	36 (34-39)	0.48 (0.45-0.50)	0.63 (0.62-0.64)	c, g	1	10
<i>R. cyanoloma</i>	48 (45-54)	0.68 (0.63-0.76)	0.87 (0.80-0.95)	c, g	4	40
<i>R. nr. flexirena</i>	26 (23-33)	0.46 (0.39-0.50)	0.68 (0.66-0.73)	c, p/c, g	3	25
<i>R. microspila</i>	39 (33-43)	0.49 (0.42-0.59)	0.63 (0.56-0.71)	c, g	11	102
<i>R. ophiocoma</i>	25 (21-29)	0.43 (0.38-0.49)	0.63 (0.57-0.69)	c, r, g	9	89
<i>R. tortisigna</i>	30 (26-33)	0.43 (0.41-0.48)	0.59 (0.55-0.63)	c, g	4	40
<i>R. sp. 1</i>	34 (31-36)	0.41 (0.39-0.42)	0.56 (0.55-0.56)	c, g	1	10
<i>R. sp. 3</i>	31 (25-37)	0.45 (0.41-0.50)	0.64 (0.57-0.73)	c, r, g	6	58
<i>R. sp. 7</i>	27 (24-29)	0.49 (0.46-0.50)	0.72 (0.69-0.74)	?c, r, g	1	10
<i>R. sp. 8</i>	36 (35-38)	0.47 (0.43-0.49)	0.63 (0.57-0.63)	c, g	1	10
<i>R. sp. 9</i>	34 (33-36)	0.51 (0.45-0.55)	0.62 (0.62-0.63)	c, g	1	3

TABLE 2

Egg incubation durations and fecundity and longevity of females at 18-22°C.

Species	Incubation (days)	Number of eggs laid max.	ave	Longevity (days) max.	ave	N
<i>R. atra</i>	12-14	—	—	—	—	1
<i>R. nr. capularis</i>	12-19	—	—	—	—	2
<i>R. nr. cryphaea</i>	8-18	375	—	7	—	1
<i>R. cyanoloma</i>	9-15	74	48	8	7	5
<i>R. nr. flexirena</i>	5-14	118	104	16	11	3
<i>R. microspila</i>	23-48	211	121	31	15	10
<i>R. ophiocoma</i>	10-24	359	115	21	9	7
<i>R. tortisigna</i>	11-17	315	144	8	6	4
<i>Rictonis</i> sp. 1	14-21	106	—	12	—	1
<i>Rictonis</i> sp. 3	7-23	307	93	12	7	8
<i>Rictonis</i> sp. 7	9-18	343	—	8	—	1
<i>Rictonis</i> sp. 8	8-25	128	—	8	—	1
<i>Rictonis</i> sp. 9	9-11	40	—	4	—	1
<i>D. intermixta</i>	4-12	739	441	24	19	8
<i>S. nigerrima</i>	4-8	369	219	19	11	3
<i>N. sepultrix</i>	6-12	605	313	19	12	3
<i>N. sallaris</i>	—	100	80	11	9	2
<i>N. archephanes</i>	7-10	304	221	8	8	3
<i>P. sanguinipuncta</i>	4-15	714	307	32	16	10
<i>P. ewingii</i>	7-10	1304	400	15	9	6
<i>P. ewingii</i> *	ave 8	?	500	?	10	50

* Data from Pickett (1979).

Oviposition.— All 13 species (Table 1) examined cemented eggs by the base to a substrate and in 11 species eggs were placed singly or in occasional groups of 2-5 eggs. These 11 species oviposited with greatest frequency on the muslin jar covers. Chi squared tests based on substrate areas comparing the deviations of observed oviposition frequencies on 5 substrates with those expected from random oviposition were significant in the preceding cases. The remaining 2 species, *R. sp.* near *cryphaea* and *R. sp.* 9, placed eggs in single layered clusters of around 50 eggs on the glass jar walls. Fecundity (see Table 2) was relatively low.

Incubation.— Incubation periods (see Table 2) of some species were moderately long and, in *R. microspila* in particular, covered a wide range for eggs from any one female.

Diarsia intermixta (Guenée) (Figs 13-16)

Description of egg.— As for *Rictonis* but: vertical ribs 2.5 μ m wide; horizontal ribs 2.0 μ m wide; aeropyle vestibules 2.0 μ m diameter; horizontal ribs lying ca 25 μ m apart; vertical ribs barely widening at aeropyle loci; micropylar rosette ca 70 μ m diameter, with ca 9 cells; height 0.46 mm, range 0.39-0.50 mm, diameter 0.64 mm, range 0.59-0.70 mm, $n = 77$ eggs from 8 females; vertical ridges 35, range 28-38, $n = 180$ eggs from 8 females; colour cream when laid.

Oviposition and incubation.— *D. intermixta* placed eggs in single layered clusters of around 50 eggs, each egg being cemented by the base and with space between it and neighbouring eggs. The incubation period was short (Table 2).

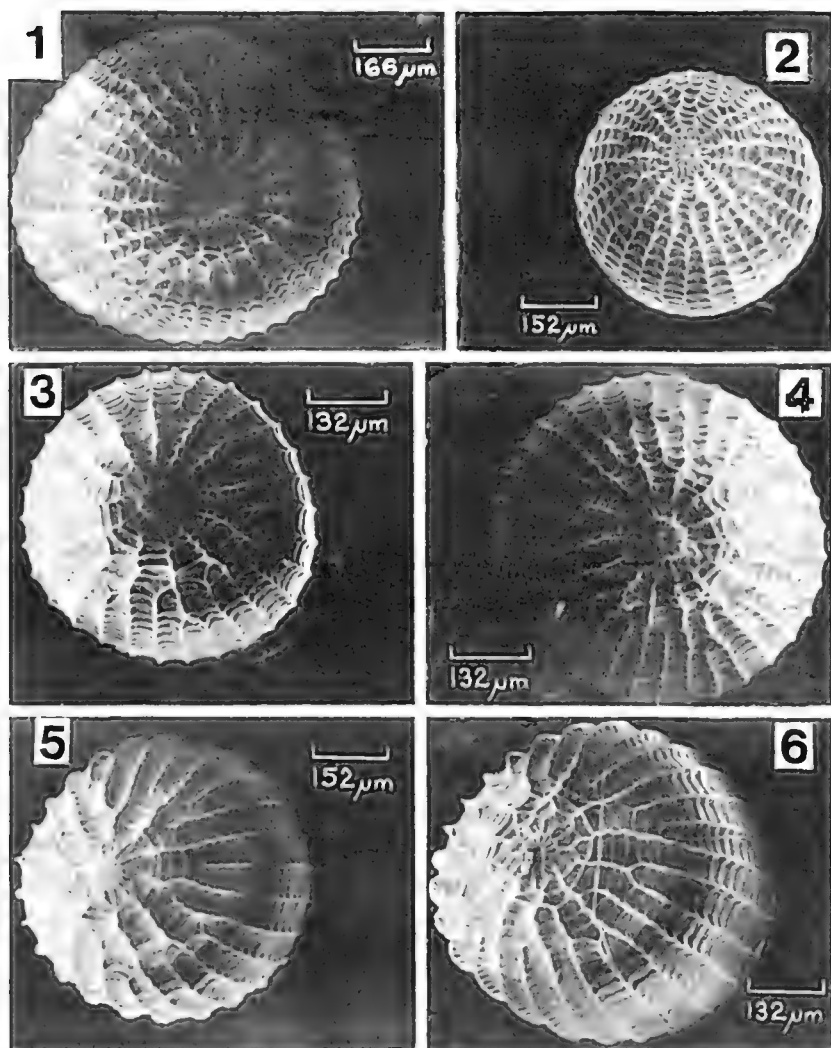
Peripyrha sanguinipuncta (Guenée)

Description of egg.— Subspherical; chorion with vertical ridges extending from outer margins of tertiary cells to near ventral pole; no smooth base; vertical ridges bearing straight longitudinal ribs, 8 μ m high, 3 μ m wide; faint horizontal ridges without ribs, lying ca 20 μ m apart, linking vertical ridges, their junctions with vertical ridges alternating along either side of latter, chorion smoother than columnar cell chorion; aeropyle vestibules 2 μ m diameter, on vertical ridges at junctions with horizontal ridges, extending entire length of vertical ridges; vertical ridges not widening at aeropyle loci; columnar cell chorion bearing numerous granules 1-2 μ m diameter; micropylar rosette ca 60 μ m diameter, with ca 13 cells, at same level as dorsal shoulders of vertical ridges; height 0.60 mm, range 0.56-0.66 mm, diameter 0.62 mm, range 0.56-0.66 mm, $n = 56$ eggs from 6 females; vertical ridges 26, range 22-29, $n = 217$ eggs from 6 females; colour cream when laid.

Oviposition and incubation.— *P. sanguinipuncta* did not cement its eggs to any substrate but scattered them loosely on the floor of the oviposition jar. Fecundity was moderately high and incubation duration was short (Table 2).

Syntheta nigerrima (Guenée) (Figs 18, 20)

Description of egg.— Domed; chorion with vertical ridges extending from outer margins of tertiary cells to circumference of large smooth flat base;



Figs 1-6. Scanning electron micrographs of *Rictonis* eggs: (1) *cyanoloma*; (2) species 1; (3) *tortisigna*; (4) *microspila*; (5) species 7; (6) species 3.

vertical ridges without ribs; horizontal ridges similar but narrower, lying *ca* 35 μ m apart, junctions with vertical ridges alternating along either side of latter; aeropyle vestibules 5 μ m diameter, at junctions of vertical and horizontal ridges, extending entire length of vertical ridges; vertical ridges not widening at aeropyle loci; columnar cell chorion deeply pitted, appearing

densely pitted by holes *ca* 1 μm diameter in slide preparations at $\times 400$; chorion of vertical ridge-caps not deeply pitted, *ca* 9 μm wide; chorion of horizontal ridges not clearly differentiated from pitted columnar cell chorion; micropylar rosette *ca* 55 μm diameter, with *ca* 9 cells, above level of secondary and tertiary cells, at same level as dorsal shoulders of vertical ridges; height 0.43 mm, range 0.36-0.48 mm, diameter 0.65 mm, range 0.60-0.70 mm, $n = 20$ eggs from 2 females; vertical ridges 20, range 18-21, $n = 50$ eggs from 2 females; colour cream when laid.

Oviposition and incubation.— *S. nigerrima* placed eggs singly and occasionally in small groups, each egg being cemented by the base to a substrate. Incubation duration was short and fecundity relatively low (Table 2).

Neumichtis sepultrix (Guenée) (Fig. 12)

Description of egg.— As for *S. nigerrima* but; horizontal ridges *ca* 30 μm apart; aeropyle vestibules 3 μm diameter; micropylar rosette *ca* 60 μm diameter; height 0.43 mm, range 0.41-0.48 mm, diameter 0.71 mm, range 0.66-0.76 mm, $n = 20$ eggs from 2 females; vertical ridges 29, range 26-31, $n = 45$ eggs from 2 females.

Oviposition and incubation.— Oviposition was as for *S. nigerrima*. Incubation duration was short and fecundity moderately high.

N. saliaris (Guenée) (Figs 17, 19)

Description of egg.— As for *S. nigerrima* but; horizontal ridges *ca* 6 μm wide, *ca* 40 μm apart; aeropyle vestibules 6 μm diameter; chorion of horizontal ridges distinctly smoother than pitted columnar cell chorion; micropylar rosette *ca* 60 μm diameter; height 0.46 mm, range 0.38-0.53 mm, diameter 0.68 mm, range 0.64-0.74 mm, $n = 18$ eggs from 2 females; vertical ridges 19, range 17-20, $n = 28$ eggs from 2 females.

Oviposition and incubation.— Oviposition was as for *S. nigerrima*. Incubation duration is unknown and fecundity was relatively low.

N. archephanes Turner

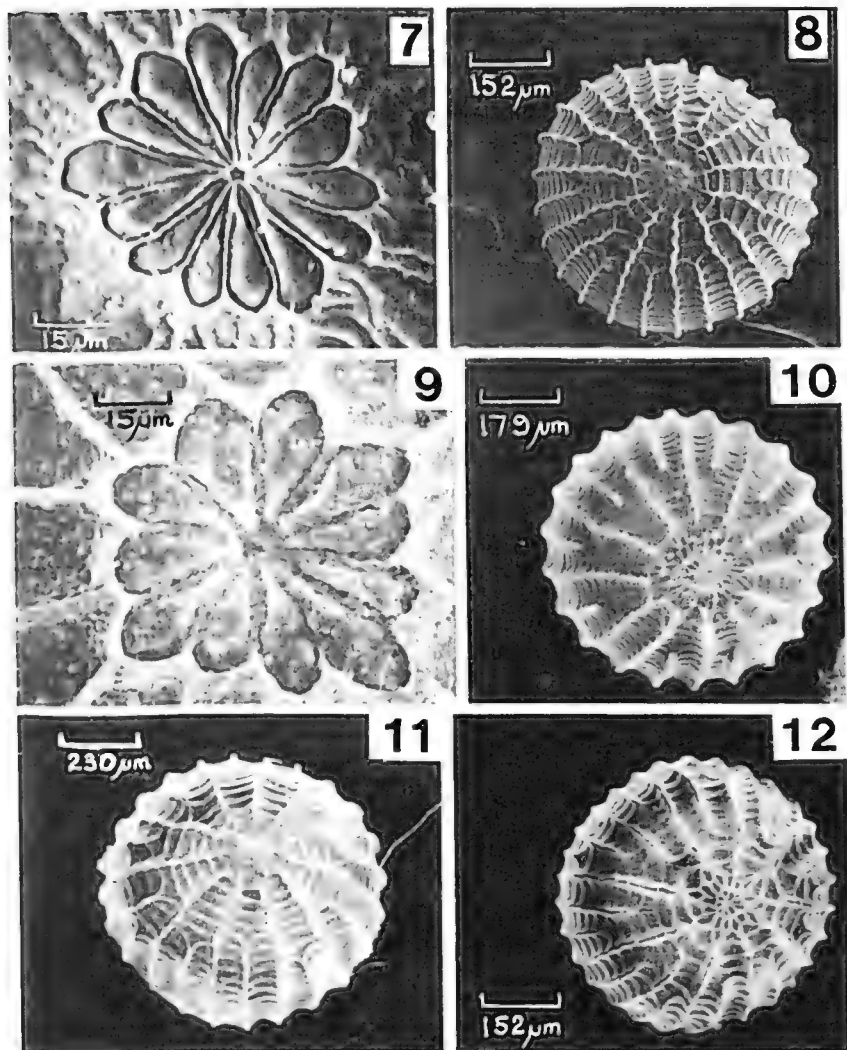
Description of egg.— As for *S. nigerrima* but; horizontal ridges *ca* 6 μm wide, *ca* 30 μm apart; aeropyle vestibules 3 μm diameter; columnar cell chorion deeply pitted near base, coarsely reticulated elsewhere; chorion of horizontal ridges distinctly smoother than columnar cell chorion; micropylar rosette *ca* 65 μm diameter; height 0.55 mm, range 0.49-0.59 mm, diameter 0.90 mm, range 0.80-0.97 mm, $n = 43$ eggs from 5 females; vertical ridges 19, range 16-22, $n = 81$ eggs from 5 females.

Oviposition and incubation.— Oviposition was as for *S. nigerrima*. Incubation duration was short and fecundity relatively low.

Comments

Egg form

Among the Tasmanian Noctuidae eggs of a domed and vertically ridged form are most common. The genera *Neumichtis*, *Euplexia*, *Rictonix*



Figs 7-12. Scanning electron micrographs of eggs: (7) *R. ophiosema*, micropylar area; (8) *R. ophiosema*; (9) *R. sp.* near *flexirena*, micropylar area; (10) ?*Euplexia* sp.; (11) ?*Euplexia* sp.; (12) *N. sepultrix*.

and the species *D. intermixta*, *Agrotis porphyricollis* (Guenée), *Corrha difficilis* Walker and *Praxis edwardsi* Guenée have eggs of a domed form with height equal to approximately three-quarters of the diameter, a large smooth flat base and pronounced vertical ridges of variable form. *Rhapsa suscitilis* Walker also possesses a domed egg but it is devoid of chorion

ridging and bears a fine and roughly hexagonal network of ribs with erect tubes bearing aeropyles at the rib junctions. The second most common egg form is the smooth subspherical to oval one found in 13 hadenine species examined. These eggs are usually laid in large groups within a supporting gel and often in crevices. Although bearing vertical ridges and ribs the egg of *P. sanguinipuncta* is subspherical in form. As noted above, eggs of this species are not cemented to any substrate but scattered loosely. They are also not supported within a gel and the well developed ridges and ribs may be associated with this lack of support.

Rictonis species

Rictonis sp. near *flexirena* differs from other species of the genus examined in possessing a granular chorion surface (similar to that of *P. sanguinipuncta*), lacking spines on the male valvae, adult seasonality (spring flying rather than autumn flying), aspects of larval morphology and rate of larval development (2 months larval duration versus 3-5 months). *R. leucosticta* also lacks spines on the male valvae and flies in spring. These two species may form part of a species group distinct from the other *Rictonis* species examined. Unfortunately the eggs and larvae of *R. leucosticta* could not be studied for comparison with *R. sp.* near *flexirena*.

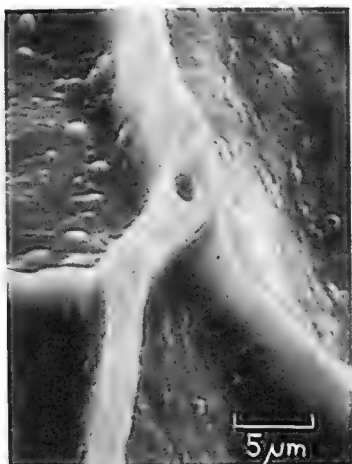
Intraspecific variation

The intraspecific ranges in vertical ridge number given here are much larger than those reported by Peterson (1964) for many American Noctuidae. A sample of 78 eggs from six *Rictonis* sp. 3 females revealed the largest ranges in vertical ridge number and egg diameter encountered during study of 13 species of this genus, viz. average ridge number 31, range 25-37, average standard deviation per female 1.35, standard error 2.89 and average diameter 0.64 mm, range 0.57-0.73 mm, average standard deviation per female 0.02 mm, standard error 0.04 mm. Average vertical ridge number for 8 females of *D. intermixta* was placed strongly towards the upper end of the range viz. average 35, range 28-38. To obtain a good measure of intraspecific ranges in ridge number and egg size it is necessary to examine at least five eggs from each of 5-10 females. These sample sizes are similar to those used by Matheny and Heinrichs (1972) and larger than those of Salkeld (1975).

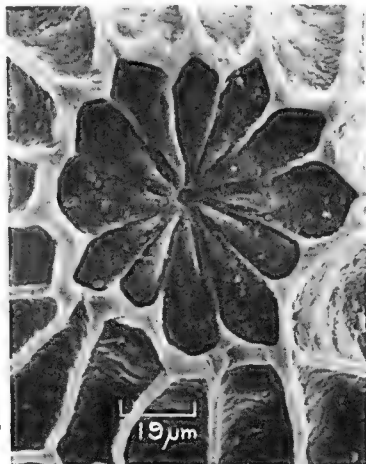
The standard deviation per female for egg height and diameter was ca 0.02 mm for all species whose eggs are described above. Heights of live eggs of *Euplexia iorrhoa* (Meyrick) were found to be as much as 15% greater than those of ethanol preserved eggs. This reduction of height by preservation probably applies to all other domed, vertically ridged eggs because these eggs become more globular upon ethanol preservation such that the height is reduced but the diameter is not greatly affected.

Ridging

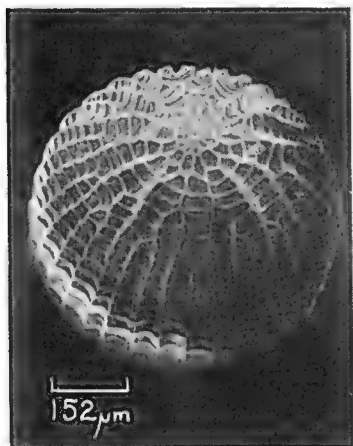
Not all vertical ridges reach dorsally to the outer margins of the tertiary cells because around one half finish before reaching this level. The fine



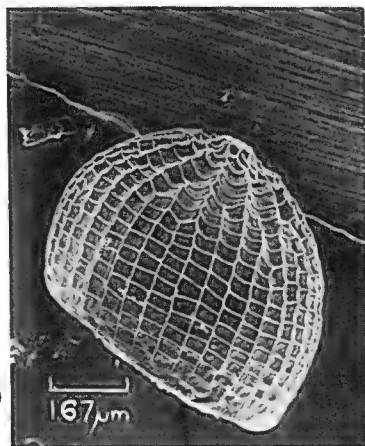
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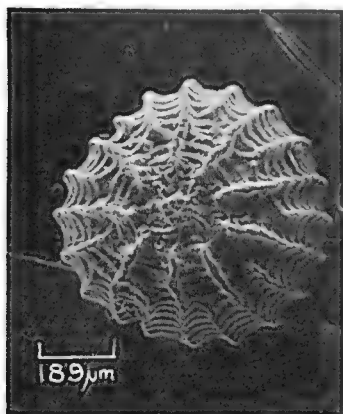


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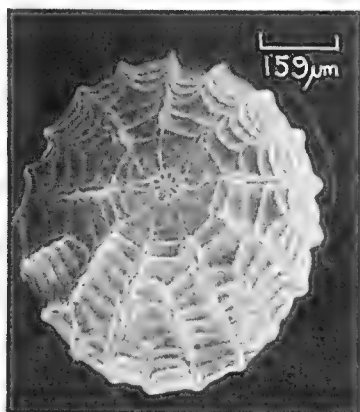
Figs 13-16. Scanning electron micrographs of *D. intermixta* eggs: (13) vertical rib and horizontal ribs at 2 aeropyle loci; (14) micropylar area; (15) dorsal; (16) lateral.

structure of the chorion cannot be observed using a dissecting microscope at $\times 80$ but the difference between vertical ridges bearing longitudinal ribs and those without can be discerned. In dorsal view of the egg the latter type of ridge appears gently rounded and ill-defined while the former type appears sharply defined. In ethanol preserved eggs whose embryos have contracted ribs appear as white lines across the chorion.

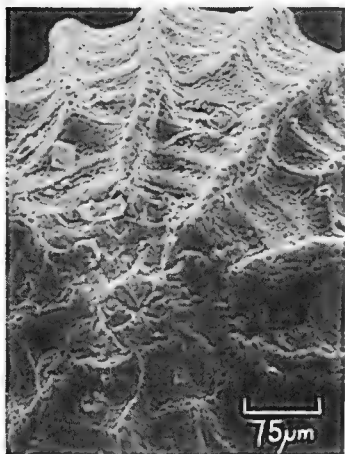
In several undetermined species of *?Euplexia*, the vertical ridges bear very wide ($11-17\ \mu\text{m}$) ribs with large ($10-15\ \mu\text{m}$ diameter) aeropyle vestibules (Figs 10, 11). The distance between neighbouring vestibules is less than their diameter so that they appear as a series of contiguous rings along each



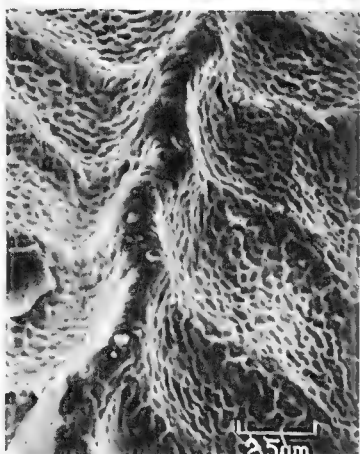
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18



19



20

Figs 17-20. Scanning electron micrographs of eggs: (17) *N. saliaris*; (18) *S. nigerrima*; (19) *N. saliaris*, dorsal; (20) *S. nigerrima*, vertical ridge.

vertical ridge in ethanol preserved eggs. Such rings cannot be discerned in the species whose eggs are described here when using a dissecting microscope.

Differences in vertical ridge structure similar to those illustrated by Döring (1955) for moth eggs were found within *Rictonis*. The vertical ridges of *R. ophiosema* appear to rise abruptly from a relatively flat columnar cell area while those of *R. microspila* rise and fall continuously around the egg equator viewed dorsally. These two types may correspond respectively to the rechteckige and flackkegelige types of Döring.

Primary cells

The micropylar rosette of primary cells is raised above the secondary and tertiary cells and at the same level as the dorsal ends of the vertical

ridges in *Rictonis*, *Peripyra*, *Neumichtis*, *E. iorrhoa*, *S. nigerrima* and *A. porphyricollis*. It is not raised above the secondary and tertiary cells in the large (ca 1 mm diameter) dark eggs of *P. edwardsi* and *C. difficilis*. Also none of the vertical ridges in these two species, whose eggs are very similar, extend dorsally to the outer margins of the tertiary cells. In *R. suscitilis* the rosette of primary cells is not raised. The elevation of the rosette can be observed with a dissecting microscope.

Ecological comments

D. intermixta, *S. nigerrima*, *N. sepultrix* and *P. sanguinipuncta* have been reported as occasional pest species in Tasmania (Hardy *et al.*, 1978). All have brief egg durations and the first three also are capable of rapid larval development given warm conditions (ca two months at 16-21°C). *P. sanguinipuncta* larvae appear to be incapable of rapid development, requiring around five months to pass from first instar to pupa at 16-21°C. Except for the relatively low fecundity of *S. nigerrima*, the first three species appear to possess opportunistic adaptations which probably contribute to their occasional pest occurrences. The relatively high fecundity of *P. sanguinipuncta* may counteract egg losses to be expected from its mode of oviposition and allow it to become a pest in neglected pastures. The relatively low fecundities, long larval durations and often long egg durations may restrain *Rictonis* species from pest status. However host plant preferences could be an important restraining factor in this large genus. *N. archephanes* is a montane species, probably univoltine and little is known of its biology.

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COVER

Illustrated by B. L. Brunet

The large and beautiful stag beetle, *Phalacrognathus muelleri* Macleay (family Lucanidae), is one of Australia's most spectacular beetles. The dominant pigmentation is maroon and green with a brilliant mirror-like sheen. Large males can measure 60 mm or more in length. The species is found only in rain forest in north-eastern Queensland where the larvae feed in decaying logs. Adults fly at dusk and rarely venture beyond rain forest margins.

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TWO NEW MINOR PESTS OF RIPE COCOA PODS IN PAPUA NEW GUINEA

By E. S. C. Smith and D. W. Kidd

Lowlands Agricultural Experiment Station, Keravat, East New Britain Province,
Papua New Guinea

Abstract

Cardiodactylus novaeguineae de Haan (Orthoptera: Gryllidae) and *Parastasia inconstans* Fairmaire (Coleoptera: Scarabaeidae: Rutelinae) are recorded as pests of cocoa pods. Spectacular, though unimportant, damage to the husk of ripe pods in three widely separated areas of Papua New Guinea is briefly described. The damage has not caused crop loss.

Introduction

Cocoa (*Theobroma cacao* L.) (Sterculiaceae) is a very attractive host tree for pests and in Papua New Guinea over 300 insect species (Szent-Ivany 1961, 1963) and 47 fungi and algae (Shaw 1963) have been recorded on the crop. Descriptions of damage and the control measures effective against the relatively few pest species which cause crop loss or tree damage have been published recently (Smith 1979, Smith 1981). During 1980, two pests which caused spectacular, though unimportant, damage to ripe cocoa pods were observed and we give below brief notes on these minor pests which feed extensively on the husk (pericarp) of pods. Since feeding damage by these two pests has not penetrated beyond the pericarp it has not exposed the beans to saprophytic or pathogenic fungi which would cause their rapid degeneration. The resultant damage has therefore not produced pod losses.

Cardiodactylus novaeguineae de Haan (Orthoptera: Gryllidae)

Damage by adult crickets was noted at Solang (Lau Island) and Derembat villages in Manus Province and at Naura village (near Alotau) and Yui Yai Plantation (Normanby Island) in the Milne Bay Province. The insect

was observed to feed on the husk of ripe pods, forming roughly conical pits up to 5 cm in diameter and 1-1.5 cm deep. Smaller, cup-shaped pits 1-2 cm across and about 1 cm deep were also eaten into the husk on some pods. Although feeding was at times quite extensive, no excavation had penetrated beyond the husk to the inner cavity (endocarp) containing the beans, and so the quality of beans was unaffected.

No previous record of this species attacking cocoa is known, although the cricket is very widespread throughout Papua New Guinea and has been collected from a wide range of crops. *C. novaeguineae* was associated with severe insect damage to robusta coffee (*Coffea canephora* Pierre) (Rubiaceae) in the Morobe and Northern Provinces (Anonymous 1969).

***Parastasia inconstans* Fairmaire (Coleoptera: Scarabaeidae: Rutelinae)**

Adults of this species, in association with *P. guttulata* Fairmaire were observed to tunnel into the husk of ripe pods on the clone K24-106 at Induna Plantation, Lower Warangoi, East New Britain Province. The entrance holes and initial tunnels were about 0.7 cm in diameter, slightly larger than that of the adults. These tunnels were enlarged and extensive ramification occurred below the husk surface forming feeding hollows up to 4 cm wide and about 0.7 cm deep. In some pods, hollowing of the husk was so extensive that the excavations affected 25% of the surface area of the pod.

An adult beetle was also observed to tunnel in a similar manner into developing jackfruit (*Artocarpus heterophyllus* Lam.) (Moraceae) and to cause young fruits to abort.

Adults of at least five species of this genus have been collected from cocoa (Szent-Ivany 1961, 1963) but only *P. guttulata* and *P. simplicipes* Ohaus have previously been recorded to damage pods, while *P. inconstans*, *P. marmorata* Gestro and *P. montrouzieri* Fairmaire were implicated as foliage feeders. All of the above species, except *P. montrouzieri* which has been recorded only in the Northern Province, are endemic to the East New Britain Province and *P. guttulata* has also been collected from several localities on the East Coast of New Ireland.

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PHYLOGENY AND RELATIONSHIPS OF THE *PAPILIO FUSCUS* GROUP OF SWALLOWTAILS (LEPIDOPTERA: PAPILIONIDAE)

By D. L. Hancock

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Abstract

The *Papilio fuscus* group of Indo-Australian butterflies is considered to comprise seven species, placed in two subgroups; viz: (1) *P. hipponous* C. & R. Felder; *P. pitmani* Elwes & de Nicéville; *P. fuscus* Goeze; *P. canopus* Westwood and (2) *P. albinus* Wallace; *P. hysicles* Hewitson, stat. rev.; *P. woodfordi* Godman & Salvin. Subgroup (1) is considered to be of Sundaland origin, whilst subgroup (2) is of Papuan origin. The *fuscus* group is closely related to the *aegeus* and *godeffroyi* groups.

Introduction

Munroe (1961) defined the *fuscus* group as having the 'adult tailed, black with more or less well-defined white postmedial band, somewhat expanded in costal half of hind wings' and 'larva smooth, green variegated with brown, without tubercles or eye-spots; hosts Rutaceae.' He placed *fuscus* Goeze and *canopus* Westwood in this group and tentatively included *diophrantus* Grose-Smith, *antonio* Hewitson, *noblei* de Nicéville, *albinus* Wallace, *hipponous* Felder, *sakontala* Hewitson, *jordani* Fruhstorfer and *walker*i Janson.

Of Munroe's tentatively included species, *albinus* and *hipponous* are confirmed as members of the group: the remainder are excluded pending further study, particularly of the male genitalia. Of these, *diophrantus*, *antonio* and *noblei* are provisionally associated with the *helenus-nephele* assemblage and *jordani* is provisionally included in the *polytes* group. The remaining species, *walker*i and *sakontala*, appear to be of hybrid origin, suggested by their pattern, wing shape and abbreviated tails, plus their being known by only one and two males respectively. One of the parent species is likely to be *polytes* Linnaeus in both cases; the other parents cannot at present be ascertained, as *polytes* is able to hybridize with many species (Ae, 1979).

Munroe (1961) defined the *woodfordi* group, which is here considered to be an integral part of the *fuscus* group, as having 'adult tailless, black and white' with 'larva lacking saddle and metathoracic band, with band of first abdominal segment narrow, oblique and raised, and with a pair of dorsal tubercles on prothorax and another on 9th abdominal segment; hosts Rutaceae'. He placed *woodfordi* Godman & Salvin and 'probably' *ptolychus* Godman & Salvin and *erskinei* Mathew in this group.

Racheli (1980) placed *ptolychus* as a subspecies of *woodfordi* and showed *erskinei* to be a subspecies of *bridgei* Mathew, a member of the *aegeus* group.

Munroe's definition of the *fuscus* group is not quite accurate: the adult is sometimes tailless and larval tubercles, although small, do exist dorsally on the prothorax and 9th abdominal segment.

Although the pattern of *woodfordi* is distinctive, characters of the male genitalia and immature stages show its close affinity with the *fuscus* group.

The *fuscus* group

The *Papilio fuscus* group can be re-defined as follows:—

Sexes similar, non-mimetic; pattern black or brown with or without a cream or white band or subapical spots on fore wing, generally with well-developed, often complete, broad or narrow cream or white postdiscal band on hind wing; submarginal pale spots absent or secondarily derived from red spots; hind wing with red and blue spots generally present; spatulate tail present or absent; male fore wing without androconia; thorax and abdomen generally with yellow lines, two lateral and one ventral lines on abdomen. Male genitalia with clasper (= harpe) apically produced into a narrow or broad, usually serrate, dorsal lobe. Mature larva solitary, variable in colour, green or orange-brown; metathoracic band and eye-spots lacking; brown band on 1st abdominal segment often present; pale patches often present on abdominal segments 2-4 and 7-8; white or blue abdominal segmental spots often present; tubercles present on prothorax and abdominal segment 9, sometimes also on segment 8. Pupa smooth; usually green; curved; thoracic protuberance a low hump. Larval food plants Rutaceae.

The seven species can be divided into two subgroups, based on the shape of the apical dilation to the male clasper. In the *fuscus* subgroup this dilation is a long, slender, serrate plate; in the *albinus* subgroup it is broad and knob-like. So far as is known, the brown form of the larva occurs only in species of the *fuscus* subgroup.

FUSCUS SUBGROUP

Papilio hipponous C. & R. Felder

Papilio hipponous C. & R. Felder, 1862, *Wien. ent. Mon.* 6: 283.

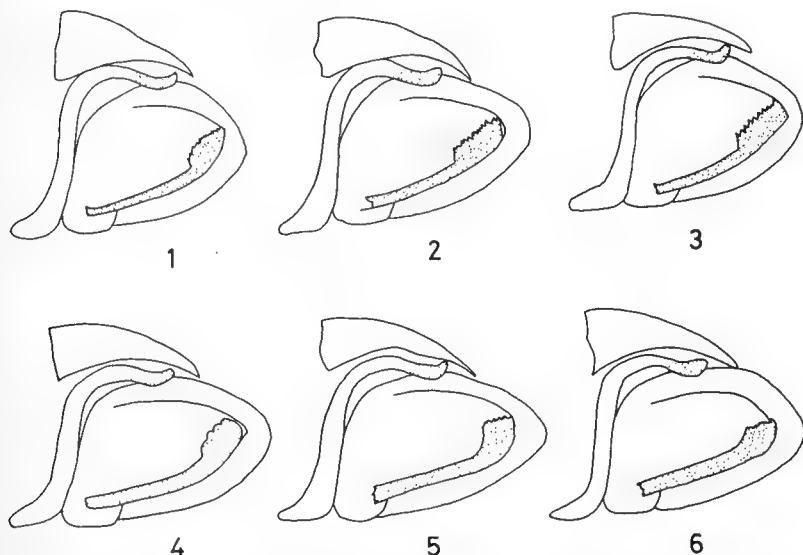
Type localities: Luzon; Mindanao (Philippines).

Fore wing generally with pale postdiscal band present above but often faint, represented below by a pair of pale spots in spaces 1b and 2; hind wing pale band relatively narrow, entire, usually slightly broader in spaces 4, 5 and 6; tail present; hind wing underside with a complete series of red submarginal spots and with blue spots in a complete series, reduced or absent.

Male genitalia (Fig. 1) typical of the subgroup.

Distribution: Two subspecies are currently recognised:— *P. h. hipponous* throughout the Philippines and Palawan; *P. h. lunifer* Rothschild on Sangir Island.

Immature stages: Described by Ae (1977). Mature larva very similar to that of *fuscus* and *canopus*, being either green or orange-brown with paler patches and abdominal blue or white spots, but has tubercles only on prothorax and ninth abdominal segment. Pupa green and smooth. Larval food plants Rutaceae.



Figs 1-6. Male genitalia (with left valve removed) of: (1) *Papilio hipponous*; (2) *P. fuscus*; (3) *P. canopus*; (4) *P. albinus*; (5) *P. hypsicles*; (6) *P. woodfordi*.

Papilio pitmani Elwes & de Nicéville

Papilio (*Laertias*) *pitmani* Elwes & de Nicéville, 1886, *J. Asiat. Soc. Bengal* 54: 434.

Papilio pitmanni Rothschild, 1894, *Novit. Zool.* 1: 685.

Type locality: Tavoy (Tenasserim, S. Burma).

Fore wing without pale postdiscal band above, present below as a pair of pale spots in spaces 1b and 2, as in *hipponous*; hind wing pale band broad to very broad in spaces 4, 5 and 6, narrow or reduced in spaces 1b, 2 and 3, better developed below; tail present; hind wing underside with a complete series of red submarginal spots but blue spots absent.

Male genitalia not studied.

Distribution: Two subspecies are recognizable:—*P. p. pitmani* has a relatively narrow hind wing pale band and is known from S. Burma and Thailand; *P. p. duboisi* Salvaza, comb. n. has the hind wing pale band broadened anteriorly and reduced posteriorly and is known only from Vietnam [Tao, Vinh province, N. Vietnam (type locality *vide* Dubois & Salvaza, 1921); Trang Bom Forest, NE of Saigon, S. Vietnam (A. Bedford Russell, pers. comm.)]. This subspecies probably also occurs in adjacent areas of Laos.

Immature stages: Unrecorded.

Comments: This species is sometimes regarded as a subspecies of *P. hipponous* and the two are certainly closely related. In view of the morphological

differences between *pitmani* and *hipponous*, and their distribution patterns (c.f. *antonio* and *noblei*), they are here maintained as separate species.

Identity of the Trang Bom Forest specimen has been confirmed by examination of photographs.

Papilio fuscus Goeze

Papilio Eques Achivus fuscus Goeze, 1779, *Ent. Beytr.* 3(1): 87.

Papilio Eques Achivus cinereomaculatus Goeze, 1779, *l.c.*: 88.

Papilio Eques Trojanus severus Cramer, 1782, *Pap. Exot.* 3: 153.

Achillades severus (Cramer); Hübner, 1816, *Verz. bek. Schm.*: 85.

Papilio severus Cramer. Godart, 1819, *Enc. Meth.* 9: 68.

Papilio castaneus var. *cinereomaculatus* Goeze; Kirby, 1877, *Cat. Diurn. Lep.*: 810.

Papilio cinereomaculatus Goeze; Ribbe, 1890, *Iris* 2: 208.

Type locality: S. Moluccas (? Amboina).

Fore wing with or without pale postdiscal band, when present generally reduced; hind wing pale band broad in spaces 4, 5 and 6, often reduced or absent in spaces 1b, 2 and 3; tail present; hind wing underside with red and blue spots generally present, often reduced.

Male genitalia (Fig. 2) typical of subgroup.

Distribution: This species has the widest distribution of the group, occurring from the Andaman Islands and Malaya to the Solomons and north-eastern Australia. Numerous subspecies have been described; their precise limits are currently under investigation by others (J. Haugum, pers. comm.).

Immature stages: Described by Straatman (1963) and Common and Waterhouse (1981). Mature larva green or orange-brown with paler patches and abdominal blue or white spots often present; tubercles present on prothorax and abdominal segments 8 and 9. Pupa green and smooth, with prominent anterior processes. Larval food plants Rutaceae.

Papilio canopus Westwood

Papilio canopus Westwood, 1842, *Ann. Mag. nat. Hist.* 9: 38.

Type locality: Melville Island (N. Australia).

Fore wing with pale postdiscal band well-marked or reduced; hind wing pale band relatively narrow becoming broader in *c. tenimberensis* Rothschild, generally entire; tail present or absent; hind wing underside with red and blue spots generally present, often reduced.

Male genitalia (Fig. 3) typical of the subgroup.

Distribution: This species occurs in the Lesser Sunda Islands and north-western Australia. Eight subspecies are currently recognised:—*canopus* (north-western Australia and Northern Territory); *tenimberensis* Rothschild (Tenimber & Baber); *vollenhovii* Felder (Timor); *croton* Fruhstorfer (Damar); *canopinus* Rothschild (Romang and Leti Is.); *hypsiclides* Rothschild (Wetar); *alorensis* Rothschild (Alor) and *umbrosus* Rothschild (Sumbawa).

Immature stages: Described by Common and Waterhouse (1981); mature larva and pupa as for *fuscus*. Larval food plants Rutaceae.

Comments: This species is very closely related to the allopatric *fuscus* and the two may be conspecific.

ALBINUS SUBGROUP

Papilio albinus Wallace

Papilio albinus Wallace, 1865, *Trans. Linn. Soc. Lond.* 25: 49.

Papilio severus var. *albinus* Wallace; Kirsch, 1877, *Mitt. Mus. Dresden* 1: 112.

Papilio albinus var. *sekarensis* Honrath, 1885, *Berl. ent. Z.* 29: 275.

Type locality: New Guinea (? Humboldt Bay).

Fore wing with pale band reduced to a series of subapical spots or absent; hind wing pale band very broad, narrowing towards tornus, present or absent in space 1b; tail present; hind wing underside with red spots often reduced, blue spots absent.

Male genitalia (Fig. 4) with apical plate of clasper broad and knob-like, not serrate.

Distribution: Two subspecies are recognised:—*P. a. albinus* lacks any pale fore wing markings and occurs in West Irian and north-west New Guinea; *P. a. lesches* Godman and Salvin has subapical fore wing pale spots present and occurs in southern Papua and adjacent areas of New Guinea.

Immature stages: Mature larva green with ventro-lateral longitudinal stripes and small tubercles on 9th abdominal segment; pupa smooth, green with broad ventro-lateral pinkish stripes (Straatman, pers. comm.). Larval food plants Rutaceae (D'Abrera, 1978).

Papilio hypsicles Hewitson, stat. rev.

Papilio hypsicles Hewitson, 1868, *Exot. Butt.* 4: t. 9. f. 29.

Papilio canopus hypsicles Hewitson; Rothschild, 1895, *Novit. zool.* 2: 341.

Type locality: New Hebrides.

Fore wing with pale band present (rarely absent); hind wing pale band narrow, entire; tail present; hind wing underside with red spots present, often not in a complete series, and blue spots present, normally in a complete series.

Male genitalia (Fig. 5) with apical plate of clasper broad and distally serrate.

Distribution: Restricted to the New Hebrides.

Immature stages: Not described.

Comments: This species has nothing to do with *canopus*, with which it is generally associated, nor with *fuscus*. In male genitalic characters it is closest, surprisingly, to *woodfordi*, a relationship which makes sense in the light of distribution patterns of the two species. Although superficially similar to *canopus*, the wings are narrower, due to shorter discoidal veins, and the pale bands are further from the wing margin; this is especially noticeable in the

fore wing, where the pale band is almost vertical for most of its length in *hypsicles* and distinctly curved in *canopus*.

Papilio woodfordi Godman & Salvin

Papilio woodfordi Godman & Salvin, 1888, *Ann. Mag. nat. Hist.* (6)1: 100.

Type localities: Alu and Fauro Is. (Solomon Islands).

Fore wing pale band entire or reduced; hind wing pale band relatively broad, entire; tail reduced to a tooth; hind wing underside with red and blue spots generally present, red spots usually a complete series.

Male genitalia (Fig. 6) with apical plate of clasper broad and distally serrate.

Distribution: Restricted to the Solomon Islands. Five subspecies are currently recognised:—*woodfordi* (Bougainville and Shortland Is.); *choiseuli* Rothschild (Choiseul); *ariel* Grose-Smith (Santa Isabel); *laarchus* Godman and Salvin (New Georgia group) and *ptolychus* Godman and Salvin (Guadalcanal and Florida Is.). Racheli (1980) also records the species from Malaita.

Immature stages: Mature larva green, with very short tubercles on prothorax and 9th abdominal segment and some faint markings; pupa smooth, dark grey to black (Straatman, pers. comm.). Larval food plants Rutaceae.

Comments: Despite its distinctive appearance, the affinities of this species are clearly with *albinus* and *hypsicles*, particularly with regard to the male genitalia.

P. ponceleti Le Moul't, a possible hybrid between *woodfordi* and *fuscus*, was discussed by Racheli (1980).

Phylogeny and Biogeography

Members of the *fuscus* group show pattern characteristics typical of several groups of south-east Asian swallowtails, i.e. a basic black and yellow (or white) pattern which may or may not become modified by mimicry. The species contained within this overall grouping correspond to Munroe's (1961) Series 1 of his Subsection A, Section II, minus the *machaon*, *xuthus* and *demoleus* groups and subgroup (b) of his *demolion* group. The remaining species form a monophyletic section within the subgenus *Princeps* Hübner (Hancock, 1978, 1979).

The *fuscus* group itself is most closely related to the *aegeus/godeffroyi* assemblage, the mature larva of these three groups lacking both the metathoracic dark band and eye-spots as well as the "typical" smooth, green with brown bands pattern characteristic of the section. The *fuscus* group differs from the other two in having a smooth pupa and in possessing few tubercles in the mature larva. The *aegeus* and *godeffroyi* groups have a rough pupa and further development of tubercles in the mature larva. The additional tubercles in these two groups are undoubtedly secondary; they are perhaps

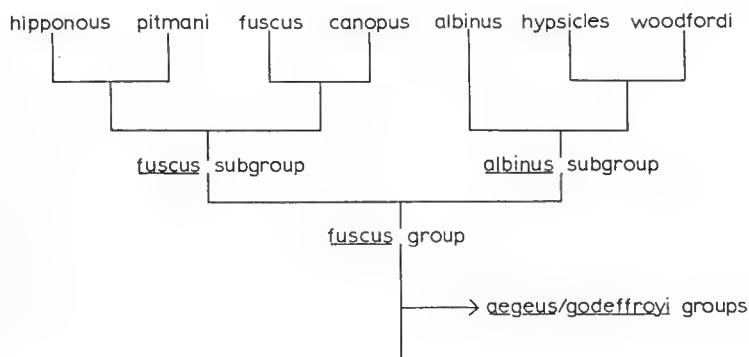


Fig. 7. Proposed phylogenetic relationships of the species of the *Papilio fuscus* group.

homologous to the abdominal pale spots of the *fuscus* group. The *aegeus* and *godeffroyi* groups are further united by the structure of the male genitalia, in that the clasper, whilst being similar to that of the *fuscus* group, has an additional, median, serrate lobe or prominent tooth. The *godeffroyi* group represents a Pacific offshoot of the Papuan *aegeus* group.

The *fuscus* group thus appears to have arisen as the sister-group to the *aegeus/godeffroyi* assemblage, the former most likely in Sundaland, the latter in New Guinea, following dispersal of an ancestral species from south-east Asia. In the Papilionidae, dispersal between south-east Asia and New Guinea appears to have been unidirectional, from west to east, no examples of Papuan-centred species or groups having extended westwards beyond the Moluccas, whereas several waves of dispersal appear to have brought western-centred groups into the Papuan region (Hancock, 1978).

A suggested initial scenario has the *fuscus* group differentiated in Sundaland and the *aegeus/godeffroyi* assemblage in the Papuan region. The sister-lineage of these three groups, comprising most of the remaining species in this section (the *demolition* group probably diverged earlier), and represented initially by the *helenus-nephelus* assemblage, differentiated in south-east Asia, outside Sundaland.

From Sundaland there was a further dispersal to New Guinea of many groups of Papilionidae, including the *fuscus* group, which became established there as the *albinus* subgroup, leaving the *fuscus* subgroup in Sundaland. From New Guinea (*albinus*) the group dispersed to the Solomons and New Hebrides, differentiating as *woodfordi* and *hypsicles* respectively. It appears likely that *hypsicles* reached the New Hebrides via the Solomons whereas other Pacific species [e.g. *godeffroyi* group, *Graphium gelon* (Boisduval), *P. montrouzieri* Boisduval] appear to have dispersed from south-east Papua to New Caledonia and beyond, avoiding the New Hebrides. A further example of

Solomons to New Hebrides dispersal is seen in *Graphium sarpedon* (Linnaeus), in recent times (Gross, 1975).

The Sundaland population, meanwhile, spread to Indo-China as *pitmani* and from there to the Philippines as *hipponous* (or *vice versa*), leaving *fuscus*, which subsequently reached the Lesser Sundas as *canopus*. The species of each subgroup are allopatric; only *fuscus*, a highly dispersive species that has extended throughout New Guinea to the Solomons and north-east Australia, occurs sympatrically with species of the *albinus* subgroup. From the Lesser Sundas, *canopus* reached north-western Australia.

The suggested phylogenetic relationships of the species are shown in Fig. 7.

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A REAPPRAISAL OF *CLEMATOSTIGMA* ENDERLEIN WITH NOTES ON RELATED GENERA (PSOCOPTERA: PSOCIDAE)

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Abstract

Clematostigma Enderlein is redefined and compared with other genera of the *Copostigma-Clematostigma-Ptycta-Maheella* complex. Each is defined as far as available data allow and species for each listed where feasible in an attempt to reduce some of the confusion surrounding these genera. A neotype is designated for *Copostigma maculiceps* Enderlein, the type species of *Clematostigma*. *Tanystigma* gen. nov. and *Tiliapsocus* gen. nov. are proposed as genera to hold species which cannot be retained as being congeneric with the type species of *Clematostigma*.

Introduction

Enderlein (1903) erected the genus *Copostigma* to hold those species of Psocinae in which there is a spurvein arising from the posterior angle of the pterostigma. He designated *C. dorsopunctatum* Enderlein, from New Guinea, as type species, and included *C. fumatum* Enderlein, from New Guinea, *C. maculiceps* Enderlein, from Australia, *C. indicum* Enderlein, from India, *C. brevistylus* Enderlein, from New Guinea and *Psocus palliatus* Hagen, from Ceylon.

Later (Enderlein 1906) he erected *Clematostigma*, with *C. maculiceps* as type species and included, amongst others, all the species previously in *Copostigma* except *C. dorsopunctatum* and *C. palliatum*. The latter was not mentioned but is, in fact, a species of Caeciliidae. *Copostigma* was thus reduced to a monotypic genus. He distinguished the two genera, both of which have a pterostigmal spurvein, by the fusion of Rs and M in the fore wing in *Clematostigma* and by these veins being joined by a crossvein in *Copostigma*.

Subsequently (Enderlein 1925) he erected the genus *Ptycta*, with *Psocus haleakalae* Perkins, from Hawaii, as type species and distinguished it from *Clematostigma* by its having the first section of Cu_{1a} shorter than the second; he pointed out that in *Ptycta* the pterostigmal spurvein was not always clearly developed. His definition of *Ptycta* implies that in *Clematostigma* the first section of Cu_{1a} is longer than the second and it is shown so in his earlier illustration (Enderlein 1906, Pl. 23, fig. 3).

In the same paper (1925) he also erected the monotypic genus *Mecampsis*, with *M. cinctifemur* from Chile, as type species. He distinguished *Mecampsis* from *Copostigma* by the first and second sections of Cu_{1a} being in a straight line or almost so. His comparison implies that in *Mecampsis* Rs and M are not fused for a length and that in *Copostigma* the two sections of Cu_{1a} are at an angle to each other. The latter is confirmed by his figure of *C. dorsopunctatum* (Enderlein 1903, Pl. IV, fig. 15).

To the above four genera he added *Maheella* (Enderlein 1931) from the Seychelles, with *M. laevidorsum* as type species. *Maheella* cannot be distinguished from *Ptycta* on the basis of his definitions and is now generally regarded as

being theoretically synonymous with it although it may be distinguishable in practice. Study of the type of *Maheella* is necessary before the matter can be settled.

With venational characters defining these genera and given the variation sometimes found in the development of the pterostigmal spurvein and the relationships between Rs and M there has inevitably been, in the absence of information on other features such as genitalia, uncertainty regarding the placing of many species. Badonnel (1967) has referred to this group of genera as the *Copostigma-Clematostigma-Ptycta-Maheella* complex.

To this complex of genera should be added *Indiopsocus* Mockford, with the North American *Psocus texanus* Aaron as type species (Mockford 1974). This genus was erected to hold a group of North American and Cuban species. It is clearly very closely related to *Ptycta*.

The problem of generic definition has been aggravated by several factors. Species recently placed in *Ptycta* have included some with and some without a pterostigmal spurvein and some with various Rs-M relationships ranging from those in which Rs and M are fused through those in which these veins meet in a point to those in which a distinct crossvein is present. The types of *C. dorsopunctatum* and *C. maculiceps* deposited in the Hungarian Natural History Museum have been destroyed by fire. Roesler (1944), in a key to the genera, placed *Clematostigma* and *Mecampsis* as subgenera of *Copostigma*. He also introduced the unreliable character of presence or absence of marginal wing setae as differentiating *Ptycta* from the other genera. This was not used by Enderlein in his original diagnosis.

Material at present being studied and papers by several authors (e.g. Badonnel 1967, New 1974, Smithers 1977) indicate that there are many species involved in this complex. If they continue to be placed in ill-defined genera or in a "holding" genus, such as *Psocidus* Pearman, their value as data in group relationship or zoogeographic studies is reduced. It is, therefore, important that an attempt be made to clarify the matter as much as possible without waiting for a complete revision of the family.

Material of Psocidae now available includes some which is undoubtedly referable to *C. maculiceps*. It was collected at the type locality, Sydney. A redescription of *Copostigma maculiceps* Enderlein [= *Clematostigma maculiceps* (Enderlein)] and designation of a neotype of *Copostigma maculiceps* is given here and provides a base from which the problems of this complex may be approached.

Redescription of *Copostigma maculiceps* Enderlein

(Figs 1-8)

MALE

Coloration (in alcohol). Head yellowish brown with dark brown markings (cf. Enderlein 1903, Pl. IV, fig. 12). Median epicranial suture very dark, anterior arms evanescent but a broad brown line occurs in their position. Irregular confluent spotting on either side of median epicranial suture, across

back of head and adjacent to inner margin of compound eyes. A brown mark between lateral ocellus and nearest mark of those adjacent to compound eye. Ocellar tubercle brown. Brown patch with pale centre between ocellar triangle and epistomial suture. Postclypeus with twelve parallel brown lines, the two middle ones closer together than others. Anteclypeus pale anteriorly, dark brown posteriorly. Labrum dark brown with paler anterior band, the band interrupted by two dark spots, one on either side of midline. Genae not marked. Scape and pedicel brown, as is basal part of first flagellar segment; remainder of antenna darker. Eyes black. Maxillary palp pale, third segment brown, fourth segment darker, almost black. Mesothoracic antedorsum shining dark brown; parapsidal sutures pale so that the mesothoracic notum is marked with a pale V; dorsal lobes dark brown with pale line posterolaterally. Mesoscutellum brown, the mesonotum laterad of scutellum very dark brown. Fore coxae pale, others dark brown. Femora pale brown with narrow dark apical band; tibiae and tarsi dark brown. Fore wings (Fig. 1) hyaline with dark brown pterostigma which is a little paler towards wing base and with dark brown postpterostigmal mark ending abruptly at spurvein. Veins brown. Hind wings hyaline, veins brown. Abdomen pale with irregular darker annulations; terminal structure dark brown.

Morphology. Length of body: 3.0 mm. Median epicranial suture very distinct, anterior arms evanescent (but position marked by brown band). Epistomial suture transverse in middle, curving forwards laterally to antennal sockets. Length of flagellar segments: f_1 : 0.92 mm; f_2 : 0.84 mm. Setae on antennae up to three times flagellum width. Eyes fairly large but not reaching level of vertex. IO/D (Badonnel): 1.9; PO: 0.9. Ocelli large, anterior ocellus a little smaller than lateral ocelli. Measurements of hind leg: F: 0.76 mm; T: 1.64 mm; t_1 : 0.44 mm; t_2 : 0.16 mm; rt: 2.8: 1; ct: 20, 4. Hind tibiae long and slender; first tarsal segment slightly curved. Fore wing length: 3.7 mm; width: 1.4 mm. In fore wing Sc ends free in costal cell. Pterostigma concave before hind angle. Spur vein present at hind angle, poststigmal mark ends at spurvein. Rs and M fused for a length. Discoidal cell distally slightly concave, sides of cell not parallel. First and second sections of Cu_{1a} at an angle to each other, not in the same straight line, second section obviously shorter than first. Hind wing length: 2.6 mm; width: 1.0 mm. Rs and M fused for a fairly long length. A few minute marginal setae between arms of radial fork. Ninth tergite unusual, extended back at sides and medially between the paraprocts; lateral extensions with irregularly serrate inner margin; median backward extension bears the epiproct. Epiproct (Fig. 3) reduced, bilobed posteriorly, lightly sclerotized except for two longitudinal sclerotized bars and bearing a pair of large, lightly sclerotized, erect lobes; apex with two setae. Paraprocts (Fig. 3) elongate, well sclerotized with large, circular trichobothrial field and with a terminal upturned lobe. Hypandrium (Fig. 6, postero-ventral view) bowl shaped, upturned behind; the upturned section broadly bilobed; basal part with a short, strongly sclerotized curved marginal bar on each side. Phallosome (Fig. 2) closed posteriorly with very large, outwardly curved, apically split outer parameres.

FEMALE

Coloration (in alcohol). Head as in male but markings paler, brown rather than dark brown. Antennae paler than in male. Maxillary palps with only fourth segment dark. Legs as in male but tibiae dark only at distal end, otherwise pale brown. Fore wing (Fig. 7, cf. also Enderlein 1906, Pl. 23, fig. 3) hyaline marked in shades of brown.

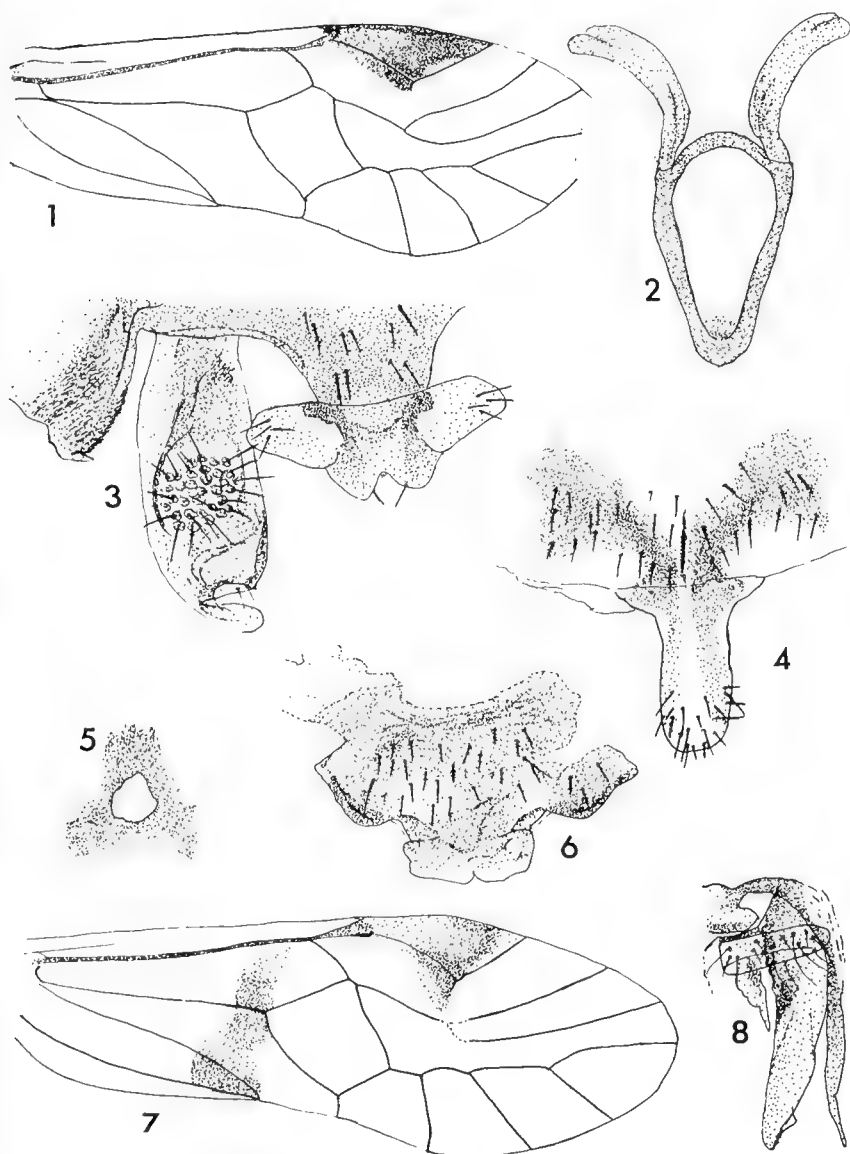
Morphology. Length of body: 3.6 mm. Epicrainal suture as in male. Length of first flagellar segment: f_1 : 1.0 mm. Eyes smaller than in male, the top of the eyes well below vertex. IO/D (Badonnel): 2.5; PO: 0.9. Anterior ocellus much smaller than lateral ocelli. Measurements of hind leg: F: 0.88 mm; T: 1.88 mm; t_1 : 0.44 mm; t_2 : 0.20 mm; rt: 2.2: 1; ct: 19, 4. Fore wing length: 4.3 mm; width: 1.5 mm. Fore wing (Fig. 7) venation similar to that of male; second section of Cu_{1a} much longer relative to first section than in male. Hind wing length: 3.2 mm; width: 1.1 mm. Venation and setae as in male. Epiproct lightly sclerotized, about as long as basal width but narrowing a little posteriorly; lateral margins in basal half strengthened by a sclerotized bar on each side, the ends of which are connected across the middle of the epiproct by a slightly narrower but similar bar; scattered, long, fine setae occur mainly distad of the transverse bar. Paraprocts broadly triangular, sclerotized, with large, round trichobothrial field. Subgenital plate (Fig. 4) with long posterior lobe and Y-shaped pigmented area, the stem of the Y extending into posterior lobe as a double band; arms of Y broadened anteriorly and stem widened a little near origin of arms of Y, Gonapophyses (Fig. 8) with very long ventral and dorsal lobes, both pointed. External valve narrowly transverse with a tapering posterior lobe. Sclerification of ninth sternite (Fig. 5) ring like with a small anterior rugose area.

MATERIAL EXAMINED. NEW SOUTH WALES: 1 ♂ (neotype), Ryde, 2.ix.1972, J. V. Peters; 1 ♂, 8 ♀, same data as neotype; 1 ♀, College St., Sydney, 3.iii.1975, C. N. Smithers; 5 ♀, Lindfield, 19.xi.1970, J. O'Regan; 1 ♂, Woronora River, Engadine, 20.x.1973, G. A. Holloway; 3 ♀, Lindfield, 28.x.1971, A. S. Smithers; 1 ♂, 3 ♀, 14 nymphs, Ryde, 5.iv.1974, J. V. Peters; 1 ♂, 1 ♀, Lindfield, 10.xi.1970, A. S. Smithers; 2 ♀, Ryde, 30.iii.1974, J. V. Peters (AM); 11 ♂, 12 ♀, Lindfield, 19.xi.1970, C. Trickett (HM). Neotype and other material is in the Australian Museum (AM) and the Hungarian Natural History Museum (HM).

Discussion and conclusions

This material reveals that *Clematostigma* has several unusual features not apparent from earlier descriptions and that some of the features used earlier are sufficiently stable to warrant their use in comparing species in several genera. Of particular note are the following.

The pterostigma has a distinct hind angle, that is the pterostigma is concave basad of the point at which the pterostigmal spurvein arises. The spurvein is always present but variable in degree of development. Rs and M are fused in the fore wing. The first section of Cu_{1a} is longer than the second, somewhat sinuous in the male and at an angle to second. The male fore wing



Figs 1-8. *Clematostigma maculiceps* (Enderlein). (1) ♂ fore wing; (2) ♂ phallosome; (3) ♂ epiproct, paraproct, ninth tergite; (4) ♀ subgenital plate; (5) ♀ spermathecal entrance; (6) ♂ hypandrium; (7) ♀ fore wing; (8) ♀ gonapophyses.

is hyaline except for the pterostigma and the postpterostigmal mark whereas the female has in addition a variably developed nodal mark (cf. Enderlein 1906, Pl. 23, fig. 3). The male has a pair of erect, setose lobes near the base of the epiproct. The paraprocts do not have a basal lobe. The hypandrium is symmetrical, not adorned with teeth, apophyses nor other projections and does not have a median, upcurved, straplike posterior extension. The phallosome is closed behind by the arch-like inner parameres and has two very large, outwardly curved external parameres. The female subgenital plate has a long posterior lobe with Y-shaped sclerotization, the stem of the Y being divided to the end of the lobe by a more lightly sclerotized area. The ventral and dorsal valves of the gonapophyses are very long and the external valves narrow and transverse with a clearly developed, narrow based, tapering lobe arising from the dorsal side.

The above features in combination can be considered to characterize *Clematostigma*. Of special significance is the form of the male phallosome which is closed with large external parameres, unusual for the Psocidae. Most species either lack obvious external parameres and have the phallosome in the form of a closed ring or they have a posteriorly open phallosome with posteriorly directed external parameres. In the extreme form (e.g. Amphigerontiinae) the phallosome is reduced to two separate sclerites, each possibly representing the external paramere of one side. In the female the elongate gonapophyses and the form of the external valve lobe are characteristic.

The peculiarities of the features described above warrant retention of *Clematostigma* at generic rank.

There are at present sixteen described species in *Clematostigma*, five in *Copostigma*, one in *Mecampsis*, seventeen in *Indiospocus* and fifty seven in *Ptycta*.

Of the sixteen species in *Clematostigma* the morphology of only eight is reasonably well known and seven of these differ from *C. maculiceps* in some important features. None of the known males has a closed phallosome. The subgenital plates and dorsal and ventral valves of the gonapophyses are not long and the lobe on the external valve does not present the unusual form found in *C. maculiceps*. On the basis of these differences they cannot be retained as congeneric with *C. maculiceps*. The species involved are *C. dubium* New, *C. edwardsi* New, *C. inglewoodense* New, *C. latimentula* Smithers, *C. paulum* Smithers, *C. tardipes* Edwards and *C. morio* (Latreille). The position of the remaining eight species [*C. brevistylus* (Enderlein), *C. fumatum* (Enderlein), *C. hyalinum* (Okamoto), *C. indicum* (Enderlein), *C. paraguayense* Enderlein, *C. subcostalis* (Okamoto), *C. tunicum* Enderlein and *C. vinctum* (Enderlein)] cannot be discussed without further studies and for the present they must remain in *Clematostigma*. *Clematostigma* is, therefore, regarded here as a genus in which only one species has been well characterized with the eight additional species listed above as being attached to it pending further study.

Amongst the seven reasonably well known species listed above which require removal from *Clematostigma* two groups can be distinguished each of which should be given generic rank.

Clematostigma morio, a parthenogenetic species, stands apart from the others in having a subgenital plate which has a short, rounded posterior lobe; the dorsal valve is fairly short and broad. The pterostigma is concave basad of the distinct hind angle. For this species the name *Tiliapsocus* gen. nov. is proposed with *Psocus morio* Latreille as type species.

The remaining species have a relatively shallow pterostigma; the known males have a posteriorly open phallosome and a symmetrical hypandrium without teeth or apophyses. For this group I propose the name *Tanystigma* gen. nov., with *Copostigma* (*Clematostigma*) *paulum* Smithers as type species. Other species to be included are *C. dubium*, *C. edwardsi*, *C. inglewoodense*, *C. latimentula* and *C. tardipes*.

Clematostigma and *Tanystigma* both differ from the species in the *Indiopsocus* and *Ptycta* complex in the form of the male phallosome which is closed in the *Indiopsocus-Ptycta* complex but without external parameres.

Comments on *Copostigma* and *Mecampsis*

Copostigma was defined on venational features. After removal to *Tanystigma* of the species described by me in *Copostigma* (*Clematostigma*) [in the sense of Roesler (1944)] (Smithers 1977) there remain only *C. dorsopunctatum*, *C. insolitum* Banks, *C. laconia* Banks, *C. pindapaiense* Williner and *C. trimaculata* (Hagen), the last named having been transferred to *Copostigma* by Banks (1938). Of these only *C. dorsopunctatum* and possibly *C. trimaculata* agree with the generic definition; *C. insolitum*, *C. laconia* and *C. pindapaiense* appear to agree, according to the illustrations provided with the descriptions, with the definition of *Mecampsis* in that the first and second sections of Cu_{1a} are in a straight line and the first section is longer than the second. It may be of significance that these three species are New World species, as is *M. cinctifemur*, whereas *C. dorsopunctatum* is from New Guinea and *C. trimaculata* from Ceylon.

Unfortunately, there is at present no material for study of additional morphological features. It is clear, however from the illustration of *C. dorsopunctatum* that the first and second sections of Cu_{1a} are at an angle, with the first shorter than the second.

Summary of generic definitions and species lists

The information available from the study of new material of *Clematostigma maculiceps* provides an opportunity to present a summary of the known features of the genera involved in the difficult *Copostigma-Clematostigma-Maheella-Ptycta* complex. I have attempted below to summarize the features of these genera from this new material and as presented in and by inference from the literature and to give a species list for the genera other than *Ptycta*. *Ptycta* is at present being studied by Professor I. W. B. Thornton and it would be premature to attempt to list species until his work is completed.

Rearrangements and redefinitions may well be required when additional material of type species of some of the genera becomes available.

Copostigma Enderlein 1903

Rs and M joined by a crossvein. Pterostigmal spurvein present. Pterostigma broad, concave. First section of Cu_{1a} shorter than second at an angle to it. Genitalia not known.

Type species: *C. dorsopunctatum* Enderlein 1903. *Ann. hist.-nat. Mus. hung.* 1: 30, pl. IV.

Species included: *C. dorsopunctatum* and probably *C. trimaculatus* (Hagen).

Clematostigma Enderlein 1906

Rs and M fused for a length. Spurvein present. Pterostigma broad, concave. First section of Cu_{1a} longer than second, at an angle to it. Subgenital plate lobe long. Gonapophyses long, external valve with peculiar lobe. Hypandrium symmetrical, without teeth or apophyses. Phallosome closed and with external parameres.

Type species: *C. maculiceps* Enderlein 1903. *Ann. hist.-nat. Mus. Hung.* 1: 231, pl. IV.

Species included: *C. maculiceps* and possibly the following: *C. brevistylus* (Enderlein), *C. fumatum* (Enderlein), *C. hyalinum* (Okam.), *C. indicum* (Enderlein), *C. paraguayense* Enderlein, *C. subcostalis* (Okam.), *C. tunesicum* Enderlein, *C. vinctum* (Enderlein).

Mecampsia Enderlein 1925

Rs and M joined by a crossvein. Spurvein present. Pterostigma concave, broad. First section of Cu_{1a} longer than second, in straight line with it. Genitalia not known.

Type species: *M. cinctifemur* Enderlein 1925. *Konowia* 4: 104.

Species included: *M. cinctifemur* Enderlein, *M. insolitum* (Banks) comb. nov., *M. pindapaiense* (Williner) comb. nov., *M. laconia* (Banks) comb. nov.

Indiopsocus Mockford 1974

Rs and M fused for a length. Spurvein present or absent. Pterostigma concave, broad. First section of Cu_{1a} shorter than second, at an angle to it. Subgenital plate variable, usually not especially long. Gonapophyses not long, external valve lobe not of form as in *Clematostigma*. Hypandrium asymmetrical, usually with teeth or apophyses. Phallosome closed, without external parameres.

Type species: *P. texanus* Aaron 1886. *Proc. Acad. nat. Sci. Philad.* 38: 16.

Species included: *I. affinis* Mock., *I. alticola* Mock., *I. bisignatus* (Banks), *I. camaguayensis* Mock., *I. ceterus* Mock., *I. cubanus* (Banks), *I. dentatus* Mock., *I. infumatus* (Banks), *I. insulans* (Chapman), *I. jamaicensis* Turner, *I. microvariegatus* Mock., *I. palisadensis* Turner, *I. pallidus* Mock., *I. pulchra* Turner, *I. texanus* (Aaron), *I. ubiquitus* Mock., *I. variegatus* Mock.

Ptycta Enderlein 1925

Characters as for *Indiopsocus* except some species have Rs and M joined by a crossvein and the phallosome is usually narrower anteriorly than in *Indiopsocus*.

Type species: *P. haleakalae* Perkins 1899. *Fauna Hawaii* 2: 77.

Species included are not listed here as the genus is currently being studied by Professor I. W. B. Thornton and such a list may be misleading at this time.

Tanystigma gen. nov.

Rs and M fused for a length. Spurvein present. Pterostigma elongate, relatively narrow, concave or convex basad of spurvein. First section of Cu_{1a} longer than second and at an angle to it. Subgenital plate lobe short. Gonapophyses short, external valve lobe not of form as in *Clematostigma*. Hypandrium symmetrical, with teeth or apophyses. Phallosome open posteriorly, with external parameres.

Type species: *C. paulum* Smithers 1977. *Rec. Aust. Mus.* 31(7): 283, figs 75-85.

Species included: *T. dubium* (New) comb. nov., *T. edwardsi* (New) comb. nov., *T. inglewoodense* (New) comb. nov., *T. latimentula* (Smithers) comb. nov., *T. paulum* (Smithers) comb. nov., *T. tardipes* (Edwards) comb. nov.

Tiliapsocus gen. nov.

Rs and M fused for a length. Spurvein present. Pterostigma concave, broad. First section of Cu_{1a} shorter than round. Gonapophyses short, external valve lobe not conspicuous. Parthenogenetic.

Type species: *P. morio* Latreille 1794. *Bull. Soc. philom. Paris* 1: 85.

Only one species: *T. morio* (Latreille) comb. nov.

Key to genera of Psocinae with a spurvein on pterostigma

The following key should be used as an aid to identification only; the full generic definitions should always be consulted as there is considerable variation in *Ptycta*, which is only dubiously separable from *Indiopsocus*.

1. Pterostigma elongate, narrow; hind margin concave or convex basad of spurvein *Tanystigma*
- Pterostigma broad, concave basad of spurvein 2
2. Rs and M joined by a crossvein 3
- Rs and M fused for a length 4
3. First section of Cu_{1a} shorter than second and at an angle to it
- First section of Cu_{1a} longer than second and in a straight line with it *Copostigma*
- First section of Cu_{1a} longer than second . . . *Clematostigma* (some *Ptycta*)
- First section of Cu_{1a} shorter than second 5
5. Subgenital plate with short, rounded, posterior lobe *Tiliapsocus*
- Subgenital plate with posterior lobe of various forms but not as in *Tiliapsocus* *Ptycta* and *Indiopsocus*

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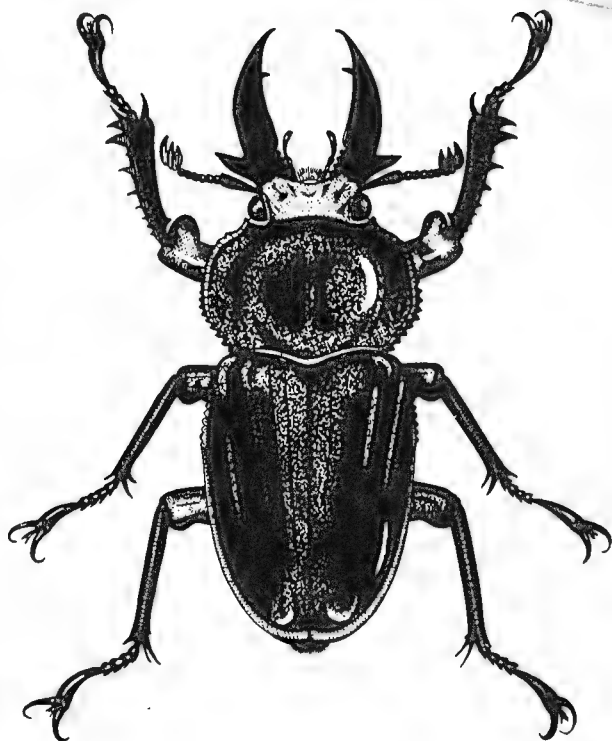
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COVER

Illustrated by B. L. Brunet

The large and beautiful stag beetle, *Phalacrognathus muelleri* Macleay (family Lucanidae), is one of Australia's most spectacular beetles. The dominant pigmentation is maroon and green with a brilliant mirror-like sheen. Large males can measure 60 mm or more in length. The species is found only in rain forest in north-eastern Queensland where the larvae feed in decaying logs. Adults fly at dusk and rarely venture beyond rain forest margins.

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A LIST OF THE BUPRESTIDAE (COLEOPTERA) OF THE SYDNEY BASIN, NEW SOUTH WALES, WITH ADULT FOOD PLANT RECORDS AND BIOLOGICAL NOTES ON FOOD PLANT ASSOCIATIONS

By G. A. Williams and T. Williams

C/- Post Office, Lansdowne via Taree, N.S.W. 2435

Abstract

180 species of Buprestidae are listed as having been recorded from the Sydney Basin since settlement. 143 species have been taken by the authors since 1970 representing 80% of the total. 61 species of adult food plants have been recorded by various authors and 45 of these were encountered during our study. Data on frequency status, seasonal occurrence, adult food plants, distribution and habits are given. *Stigmodera* species are viewed as significant pollinators of Myrtaceae dominated communities within the Sydney Basin and pollinator-food plant associations postulated from observations.

Introduction

Until recently little attempt had been made to survey Australian invertebrate communities with little attention given to those areas impinged upon by urban development. Of the insects, apart from the relatively well studied Lepidoptera, few orders have drawn attention and this has largely been of a taxonomic nature with distribution and frequency data derived only as an incidental adjunct. This study surveys the Buprestidae or "jewel" beetles of the Sydney Basin.

The Sydney Basin is some 36,000 sq km in extent and forms a wedge-shaped area on the eastern seaboard of New South Wales approximately delimited by Lithgow, Newcastle and Batemans Bay (Fig. 1). The study was confined to the Central and Western Areas of the Sydney Basin as figured in Branagan, Herbert and Langford-Smith (1979: 5). Altitude increases from sea-level to 1100 m at Mt. Victoria in the Blue Mountains.

Dominant rock types of the basin weather to a particularly poor soil (Gold and Prineas 1978) but nevertheless support a rich and diverse flora. Beadle, Evans and Carolin (1972) list some 2,000 species of native plants from the Sydney region; the 180 species of Buprestidae recorded here can be viewed as a reflection of that floristic richness.

Three authors have surveyed the buprestid fauna in areas within the Sydney Basin; Williams (1977) and Hawkeswood (1978) provide data on the species occurring at East Minto and Glenbrook respectively and Nikitin (1979) lists species encountered within the County of Cumberland. A considerable amount of data no doubt exist in collections, both institutional and private, but no effort has been made to intergrate such data. The efforts of early collectors, however, in amassing collections of species were not matched by an equal attention to labelling. As a consequence there is a paucity of information on the early buprestid fauna. Representations of species within collections are often inversely proportional to their natural frequency; the more common species usually being ignored in the field and those less frequently encountered consistently procured. Thus, old museum data may offer scant insight into the faunal diversity and frequency in the area.

Observations and collection of buprestids has been undertaken by the present authors for some years, especially since 1976. Our collection sites (Fig. 1) are arranged in geographical clusterings approximating the three major geologic regions (based on topography and dominating bedrocks) within the study area.

Adult food plants are listed in Table 1. Table 2 lists those buprestid species encountered primarily by the authors. The frequency status given in this table follows that of Williams (1977) and Hawkeswood (1978) where "rare" indicates fewer than three specimens, "few" means three to ten and "common" greater than ten specimens encountered over the period of study. We recognize the failings of such an arbitrary assessment but it provides a useful comparative standard. It must be emphasized, however, that the local status of a species in both space and time is often highly variable; the biology of most buprestids is totally unknown and the triggering mechanisms (rainfall, temperature etc.) that initiate emergence poorly understood. Thus a reappraisal in some instances may be required in the future.

Table 3 lists those buprestid species that have not been observed by us but are represented primarily in the collection of the Australian Museum (Sydney), and to a lesser extent, in the Henry Schrader Collection (recently sold to a number of individual collectors: the majority of the Australian *Stigmodera* now being in the collection of Mr Allen Sundholm). Primarily we have based our considerations on species personally encountered; only where species were not thus observed is recourse made to the records of other authors and museum data. Data from a previous study by one of us (Williams 1977) are repeated here for those species not encountered again since that study and for those species infrequently recorded.

In addition to those species listed in Tables 2 and 3 Hawkeswood (1978) lists from the lower Blue Mountains *Melobasis costata* Macleay, *Cisseis atroviolacea* Thomson, *C. maculata* Laporte and Gory, *C. pygmaea* Blackburn, *C. ruseocuprea* Hope and *C. vicina* Kerremans. Nikitin (1979) lists *Stigmodera jospilota* Laporte and Gory and provides a coastal record for *Stigmodera victoriensis* Blackburn. His most interesting records are for *Stigmodera goryi* Laporte and Gory, "one

living specimen was collected on a eucalypt trunk at Cabramatta on 19 Dec. 1959, and one dead specimen was excavated from a tunnel in the trunk of *Eucalyptus* sp. in Fairfield Park on 13 Aug. 1959". These represent the most recent records of this species within the Sydney Basin.

We have also seen, in the collection of Mr D.P. Carne of Sydney, specimens of what appear to be *Stigmodera mustelamajor* Thomson taken by him in the vicinity of Maroota on *Eucalyptus* blossom.

TABLE 1

List of adult food plants. Plants are listed systematically. Capital letters relate to collection sites in Fig. 1; months indicate dates of observations. Duplicates of the food plants were submitted to the National Herbarium, Sydney, for identification and a representative series lodged with N.P.W.S., Taree.

Family Proteaceae

1. *Isopogon anemonifolius* (Salisb.) Knight.—B, Dec.
2. *Banksia* sp. (unidentified).—C, Dec.; U.
3. *Hakea teretifolia* (Salisb.) J. Britt.—N, Dec.; L, Jan.

Family Mimosaceae

4. *Acacia decurrens* (Wendl.) Willd.—O, Oct., Nov., Dec.; I, V, Nov.; C, H, B, Dec.
5. *Acacia falcata* Willd.—O, Dec.
6. *Acacia longifolia* (Andrews) Willd.—C, M, K, Oct.; C, I, Nov.; I, C, Y, Z, Dec.; O, Y, Jan.
7. *Acacia obtusifolia* A. Cunn.—X, Dec.; Z, Dec.
8. *Acacia parramattensis* Tindale.—H, Dec.
9. *Acacia* sp. (unidentified)

Family Fabaceae

10. *Daviesia latifolia* R. Br.—X, Oct.
11. *Dillwynia floribunda* Sm.—L, Oct.
12. *Dillwynia retorta* (Wendl.) Druce.—X, Nov.
13. *Dillwynia sericea* A. Cunn.—U, Nov.
14. *Jacksonia scoparia* R. Br.—O, Oct.
15. *Phyllota grandiflora* (Sieb. ex DC.) Benth.—N, Oct.
16. *Phyllota phylicoides* (Sieb. ex DC.) Benth.—C1, Sep.
17. *Pultenaea brunioides* (Meisn.) J. Thompson.—R, Nov.
18. *Pultenaea ferruginea* var. *deanei* (R. T. Baker) Williamson.—O, Oct.
19. *Pultenaea elliptica* Sm.—L, N, C, B, Dec.
20. *Viminaria juncea* (Schrud.) Hoffm. —C, Dec.; K, Nov.

Family Myrtaceae

21. *Backhousia myrtifolia* Hook. f. et Harv.—C, Dec.
22. *Angophora hispida* (Sm.) D. Blaxell.—A, B; C, I, J, K, L, N, Nov., Dec.; rarely Oct. and Jan.
23. *Eucalyptus ?luehmanniana* F. Muell.—C, Dec.
24. *Eucalyptus obtusiflora* DC.—C, Dec.
25. *Eucalyptus ?racemosa* Cav.—I, Dec.
26. *Eucalyptus sieberi* L. Johnson.—C, Oct.
27. *Eucalyptus* sp. (unidentified)
28. *Leptospermum attenuatum* Sm.—C1, L, Oct.; I, J, U, Nov.; B, X, Dec.
29. *Leptospermum flavescens* Sm.—B, C, C1, D, E, H, I, J, K, L, M, N, Oct., Nov., Dec.; Q, R, U, V, W, X, Y, Z, Dec., Jan.
30. *Leptospermum juniperinum* Sm.—A, B, Dec.; Y, Z, Jan.
31. *Leptospermum parvifolium* Sm.—C1, L, Sep., Oct.; R, Nov.

32. *Leptospermum squarrosum* Sol. ex Gaertn.—C, Dec.
 33. *Leptospermum* sp. (an apparently undescribed sp.).—X, Dec., Jan.
 34. *Leptospermum* sp. (unidentified)
 35. *Kunzea ambigua* (Sm.) Druce.—B, C, C1, E, J, L, N, O, Q, R, S, Oct., Nov., Dec.
 36. *Melaleuca armillaris* (Soland. ex Gaertn.) Sm.—D, Nov.
 37. *Baeckea densifolia* Sm.—B, Dec.
 38. *Baeckea imbricata* (Gaertn.) Druce.—A, C, Dec.
 39. *Calytrix tetragona* Labill.—C1, Sep.

Family Casuarinaceae

40. *Casuarina distyla* Vent.—A, B, Y, Dec.
 41. *Casuarina cunninghamiana* Miq.—D, Oct., Nov.
 42. *Casuarina littoralis* Salisb.—A, C, O, Dec., Jan.
 43. *Casuarina* sp. (unidentified).—C, Z, Dec., Jan.

Family Santalaceae

44. *Leptomeria acida* R. Br.—X, Dec.

Family Rutaceae

45. *Eriostemon australasius* Pers.—C1, Sep.

Family Apiaceae

46. *Actinotus helianthi* Labill.—S, Nov.

Family Epacridaceae

47. *Epacris microphylla* R. Br.—Q, Oct.
 48. *Epacris obtusifolia* Sm.—C, Oct.

Family Asteraceae

49. *Cassinia aculeata* (Labill.) R. Br.—V, Dec.
 50. *Cassinia aureonitens* N. A. Wakefield.—C, Nov.
 51. *Cassinia* sp. (unidentified)
 52. *Helichrysum diosmifolium* (Vent.) Sweet.—C, Nov.

Family Xanthorrhoeaceae

53. *Xanthorrhoea* sp. (unidentified).—J, N, Dec.

Family Cunoniaceae

54. *Ceratopetalum gummiferum* Sm.—C, Nov.

TABLE 2

List of Buprestidae encountered. Species are listed systematically. Months indicate first and last dates of sightings; capital letters relate to collection sites in Fig. 1; numerals relate to adult food plants listed in Table 1. Asterisks (*) indicate records from flowers only; other species were principally recorded from foliage only. Voucher specimens have been lodged in the Australian Museum, Sydney, and a larger series retained by us.

Subfamily Buprestinae

- Agrilus australasiae* Laporte & Gory.—22 Oct.-31 Dec., common. B, C, H, I, O, V, 4, 8, 9.
 **Ethon affine* Laporte & Gory.—1 Oct.-17 Nov., common. K, N, O, T, 11, 14, 15, 18.
 **Ethon* sp. near *affine* Laporte & Gory.—30 Sep.-6 Oct., few. C, N, 15,
 **Ethon corpulentum* Boheman.—30 Sep.-18 Nov., common. C, K, X, 10.
 **Ethon fissiceps* (Kirby).—30 Sep.-14 Oct., common. C, K, L, N, 11.
 **Ethon leai* Carter.—6-18 Nov., few. Q, U, X, 12, 13.
 **Ethon* sp. near *leai* Carter.—6 Nov., rare. Q.
 **Ethon bicolor* Laporte & Gory.—30 Dec.-4 Jan., rare. Z, 29.
Cisseis acuducta (Kirby).—30 Sep.-8 Dec., common. C1, K, L, N, O, Q, T, V, X, 7, 11, 12,
 14, 15, 16, 20.
Cisseis aurocyanea Carter.—30 Dec.-4 Jan., few. Y, 6.

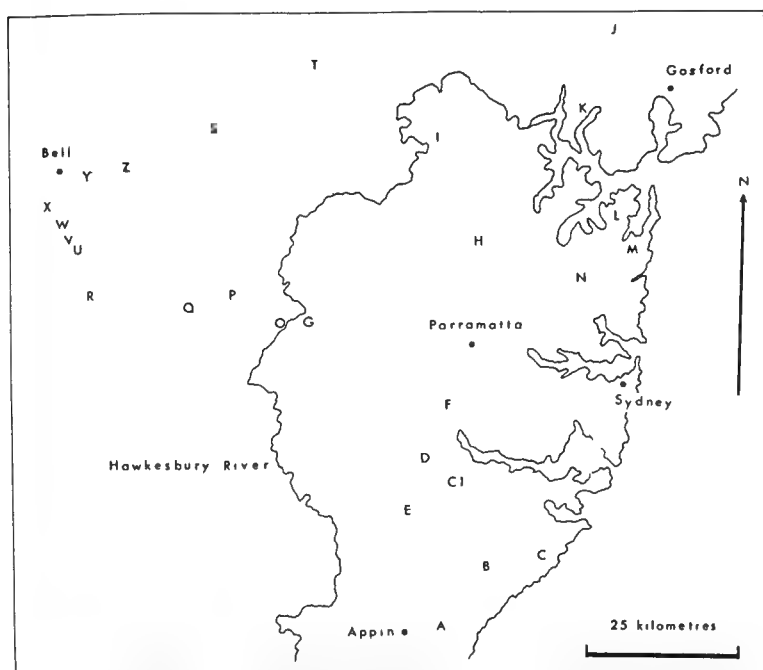


Fig. 1. List of collecting sites with description of the site vegetation. The vegetation of study sites is not necessarily typical of the immediate surrounding district.

Coastal Plain

- A. Woronora Dam: dry sclerophyll forest merging to woodland.
- B. Waterfall: dry sclerophyll forest merging to low open woodland.
- C. Royal National Park: gully restricted rain forest, dry sclerophyll forest and woodland intermixed with heath. Sites, in the main, restricted to central, eastern and north-eastern sections of the Park.
- C1. Heathcote Road; between Liverpool and Heathcote: dry sclerophyll forest merging to open woodland. Military reserve adjoins southern side of road.
- D. Glenfield: lightly timbered pasture with some areas planted to native gardens.
- E. East Minto: dry sclerophyll forest intermixed with woodland.
- F. Cabramatta: medium density residential suburb with residual areas, mainly creek restricted, of native flora.
- G. Penrith: light to medium density residential suburb at foot of Blue Mountains: scattered individual and small tree clusterings.
- H. Middle Dural: dry sclerophyll forest.
- I. Maroota: dry sclerophyll forest.
- J. Peats Ridge: tall to low woodland.
- K. Calga: dry sclerophyll forest.
- L. Ku-ring-gai Chase National Park: West Head Section. woodland.
- M. Ingleside: dry sclerophyll forest.
- N. Mona Vale Road between St. Ives and French's Forest turnoff: woodland.

Lower Blue Mountains

- O. Lapstone Hill: dry sclerophyll forest.
- P. Springwood: dry sclerophyll forest.
- Q. Woodford: dry sclerophyll forest.
- R. Katoomba: low woodland merging to exposed heath above cliff face.
- S. Mountain Lagoon: dry sclerophyll forest.
- T. Colo Heights: dry sclerophyll forest.

Western Blue Mountains

- U. Blackheath: woodland interspersed with low wind-exposed heathland.
- V. Mt. Boyce: "mallee" dominated woodland on ridge top.
- W. Mt. Victoria: dry sclerophyll forest verging to woodland.
- X. Mt. York: dry sclerophyll forest.
- Y. Bell's Line of Road between Bell and Mt. Wilson turnoff; Blue Mountains National Park: dry sclerophyll forest merging to woodland.
- Z. Mt. Wilson: dry sclerophyll forest with interspersed escarpment rain forest.

- Cisseis cupripennis* Guerin.—13 Nov.-10 Jan., common. A, C, I, X, Y, Z, 4, 6, 7, 29.
Cisseis duodecimmaculata Fabricius.—10 Dec.-29 Jan., common. J, N, P, Y, 40, 53.
Cisseis heroni Carter.—18 Nov.-26 Dec., few. I, O, 4, 5, 10.
Cisseis leucosticta (Kirby).—26 Dec.-28 Jan., common. I, P, X, Y, 6, 7, 9.
Cisseis marmorata Laporte & Gory.—25 Nov.-26 Dec., rare. I, P, 4.
* *Cisseis nitidiventris* Carter.—21 Nov.-13 Jan., common. C, L, Q, W, X, 29, 34.
* *Cisseis notulata* Germar.—21 Nov.-4 Jan., common. A, B, C, C1, H, I, J, I. N, V, X, Y, 3, 22, 28, 29, 38.
* *Cisseis obscura* Blackburn.—31 Dec., rare. A, 38.
Cisseis scabrosula Kerremans.—6 Oct.-5 Jan., common. C, I, K, M, O, Y, Z, 4, 6, 7, 9, 29, 43.
Cisseis sp. near *vicina* Kerremans.—24 Nov.-4 Jan., common. A, C, H, L, M, V, W, 29, 44.
Cisseis sp. No. 1.—7 Dec.-20 Jan., common. B, C, H, L, N, 1, 3, 8, 29, 32, 34. Small species 3-5 mm in length, dorsal surface bronze.
Cisseis sp. No. 2.—21 Nov.-5 Jan., few. C, O, 5, 6. Similar in size and colour to preceding sp. but with distinguishing areas of pubescence on dorsal surface.
Cisseis sp. No. 3.—25 Nov.-7 Dec., few. H, I, 4, 8. Small species 5-6 mm in length, pronotum nitid green, elytra black with, in fresh specimens, white dots of pubescence on the apical third.
Cisseis sp. No. 4.—30 Dec. Y, 6. Length 8 mm, pronotum bronze, elytra almost cuneate, black with an obscured pubescence.
Paracephala cyaneipennis Blackburn.—9-19 Dec., common. A, C, L, N, O, 29, 40, 41.
Paracephala murina Thomson.—16-30 Dec., common. A, B, C, 40.
Germanica lilliputana (Thomson).—9-20 Dec., common. A, B, C, L, N, O, 40, 42.
* *Merimna atrata* Hope.—15 Dec., rare. C, 22.
Astraeus crassus Van de Poll.—11 Oct.-28 Nov., common. D, 41.
Astraeus dilutipes Van de Poll.—15 Dec.-5 Jan., few. A, O, X, 42, 43.
Astraeus pygmaeus Van de Poll.—15 Dec.-5 Jan., few. A, O, 42.
Nascio vetusta Boisduval.—28 Nov., rare. C. Outside of study area we have seen this species on trunks of *Eucalyptus* sp.
Melobasis cupriceps (Kirby).—14-16 Dec., common. C, 20.
Melobasis cuprifera Laporte & Gory.—30 Sep.-30 Dec., common. C, C1, L, N, O, R, T, U, X, 10, 12, 13, 14, 16, 17, 19, 34.
Melobasis fulgurans Thomson.—15 Dec., rare X, 7.
Melobasis gloriosa (Thomson).—30 Oct., rare. P, 9.
Melobasis nitidiventris Kerremans.—6-14 Oct., rare. K, L, 9.
Melobasis purpurescens Fabricius.—29 Nov.-31 Dec., few. A, F, G, X, 6, 29.
Melobasis sp. near *semisuturalis* Blackburn.—27 Nov., rare. K, 27.
* *Melobasis* sp.—22 Oct., rare. O, 14. Dorsal surface glabrous, elytra costate.
* *Torresita cuprifera* (Kirby).—27 Oct.-11 Jan., common. C, J, X, Z, 22, 26, 29.
* *Anilara ?obscura* Macleay.—8 Dec., rare. U, 29.
Anilara sulcipennis Kerremans.—15 Dec.-5 Jan., common. O, 42.
* *Neocuris anthaxioides* Fairmaire.—25 Nov., few. I, 29.
* *Neocuris* sp. near *coerulans* Fairmaire.—16-29 Dec., few. C, U, 29.
* *Neocuris cuprilatera* Fairmaire.—7-14 Dec., rare. C, H, 29.
* *Neocuris gracilis* Macleay.—21 Nov.-11 Jan., common. C, C1, H, I, J, U, V, X, Z, 21, 28, 29, 30, 35, 46.
* *Neocuris* sp. near *gracilis* Macleay.—6 Dec.-4 Jan., few. C, Z, 21, 29.
* *Neocuris guerini* Hope.—25 Nov.-17 Dec., few. C, E, I, 29, 35.
* *Neocuris ?crassa* Obenberger.—21 Nov.-19 Dec., few. A, C, C1, 29.
* *Pseudoanilara cupripes* (Macleay).—25 Nov., rare. C, 54.
Pseudoanilara purpureicollis Macleay.—17 Dec., rare. D, 41.
* *Curis aurifera* Laporte & Gory.—7 Nov.-13 Jan., rare. D, X, 33, 36.
* *Curis caloptera* Boisduval.—2-29 Dec., few. A, C, E, Z, 22, 29.
* *Stigmodera jacquinoti* Boisduval.—13-16 Dec., rare. C1, J, 22.
* *Stigmodera macularia* (Donovan).—13 Nov.-4 Jan., common. C, E, J, U, Z, Y, 22, 29, 34.

- * *Stigmodera affinis* Saunders.—27 Dec., rare. C1, 22.
- * *Stigmodera grandis* (Donovan).—16-31 Dec., rare. C1, I, 22.
- * *Stigmodera limbata* (Donovan).—16 Dec.-13 Jan., rare. C, C1, U, 22, 29.
- * *Stigmodera* sp. near *mittelli* Hope.—15 Dec., rare. X, 28.
- * *Stigmodera suturalis* (Donovan).—16-29 Dec., common. C, C1, 22.
- * *Stigmodera thoracica* Saunders.—28 Nov., rare. F (dead on ground).
- * *Stigmodera variabilis* (Donovan).—4 Dec.-28 Jan., common. C, C1, I, U, V, W, X, 22, 29, 33, 34.
- * *Stigmodera alternecosta* Thomson.—7-26 Dec., rare. H, X, 29, 33.
- * *Stigmodera amplipennis* Saunders.—22-30 Dec., rare. C1, X, 22, 29.
- * *Stigmodera andersoni* Laporte & Gory.—6 Dec.-22 Jan., common. A, B, C, C1, E, I, J, Q, Y, 22, 29, 34.
- * *Stigmodera armata* Thomson.—22 Dec., rare. C1, 22.
- * *Stigmodera assimilis* Hope.—27 Oct.-14 Dec., common. C, C1, 22, 23, 29, 35.
- * *Stigmodera australasiae* Laporte & Gory.—27 Oct.-11 Jan., common. C, C1, E, I, J, L, O, Q, V, X, Z, 22, 27, 28, 29, 33, 34, 35, 37.
- * *Stigmodera balteata* Saunders.—26 Nov.-12 Dec., few. E, 29.
- * *Stigmodera bella* Saunders.—13 Nov.-29 Jan., common. B, C, E, J, P, V, X, Z, 22, 23, 24, 29, 33, 34, 35.
- * *Stigmodera bifasciata* (Hope).—27 Oct.-4 Jan., common. C, C1, E, J, Q, S, X, Y, Z, 22, 27, 29, 30, 34, 35.
- * *Stigmodera bremeri* (Hope).—29 Dec.-13 Jan., few. U, W, X, Z, 29, 33, 34.
- * *Stigmodera brutella* Thomson.—30 Dec.-20 Jan., rare. U, X, 29.
- * *Stigmodera burchelli* Laporte & Gory.—15 Dec., rare. C, 22.
- * *Stigmodera commixta* Carter.—29 Dec.-28 Jan., few. U, Z, 29, 34.
- * *Stigmodera costata* Saunders.—13 Nov.-16 Dec., common. C, D, 22, 23, 29, 34, 35.
- * *Stigmodera costipennis* Saunders.—14-22 Dec., rare. C1, X, 29, 34.
- * *Stigmodera crenata* (Donovan).—27 Oct.-31 Dec., common. A, C, C1, 22, 29, 35.
- * *Stigmodera cruenta* Laporte & Gory.—24 Nov.-22 Jan., common. C, C1, E, J, Q, 22, 29.
- * *Stigmodera cruentata* (Kirby).—27 Oct.-14 Dec., common. C, C1, J, L, 22, 27, 29, 34, 35.
- * *Stigmodera cupricollis* Saunders.—26 Dec.-28 Jan., few. U, V, W, X, 29, 33, 34.
- * *Stigmodera decemmaculata* (Kirby).—6 Oct.-6 Nov., common. C1, K, L, Q, 28, 31, 34.
- * *Stigmodera delectabilis* Hope.—30 Dec., rare. X, 29.
- * *Stigmodera dimidiata* Carter.—27 Oct., rare. C, 48.
- * *Stigmodera discoidea* Carter.—30 Dec., rare. Y, 29.
- * *Stigmodera erythroptera* (Boisduval).—27 Oct.-30 Dec., common. C, C1, I, J, X, Z, 22, 25, 29, 33, 34.
- * *Stigmodera flavopurpurea* Carter.—18 Dec.-4 Jan., few. U, W, Y, 29, 34.
- * *Stigmodera flavopicta* (Boisduval).—22 Oct.-29 Dec., few. C, O, Z, 29, 50, 52.
- * *Stigmodera gentilis* Kerremans.—21 Nov.-26 Dec., rare. C, Z, 29.
- * *Stigmodera grata* Saunders.—8-29 Dec., few. C1, V, X, 29.
- * *Stigmodera hilaris* Hope.—26 Dec., rare. X, 33.
- * *Stigmodera hoffmanseggii* Hope.—26 Dec., rare. V, 29.
- * *Stigmodera ignota* Saunders.—26 Dec.-21 Jan., rare. U, W, X, 29.
- * *Stigmodera imitator* Carter.—13 Nov.-13 Jan., common. C, V, X, Z, 29, 34, 35.
- * *Stigmodera indistincta* Saunders.—25-29 Dec., few. J, Z, 22, 29.
- * *Stigmodera kerremansi* Blackburn.—13 Nov.-28 Jan., common. B, C, C1, V, X, Z, 22, 23, 27, 29, 33, 34.
- * *Stigmodera kershawi* Carter.—29 Dec.-13 Jan., rare. V, W, Y, 29, 34.
- * *Stigmodera kirbyi* (Guérin).—6 Oct.-18 Nov., common. C, L, Q, R, U, 17, 22, 28, 31, 47.
- * *Stigmodera klugi* Laporte & Gory.—24 Nov.-13 Jan., few. C, C1, X, 22, 29, 35.
- * *Stigmodera luteipennis* Gory.—2-17 Dec., rare. C1, E, 22, 29.
- * *Stigmodera nasuta* Saunders.—22-30 Dec., rare. U, W, 29, 34.
- * *Stigmodera neglecta* Carter.—30 Dec., rare. Y, 29.
- * *Stigmodera octomaculata* Saunders.—21 Nov.-30 Dec., common. C, C1, V, W, X, Z, 22, 29, 33, 34.

- * *Stigmodera octospilota* Laporte & Gory.—27 Oct.-11 Jan., common. C, C1, H, I, J, L, N, Q, U, W, X, Z, 22, 28, 29, 30, 34, 35.
- * *Stigmodera parallela* White.—15 Sep.-25 Nov., common. C, C1, I, K, L, M, N, 22, 28, 29, 31, 34, 35, 39, 45.
- * *Stigmodera pertyi* Laporte & Gory.—4 Nov., rare. C1, 34.
- * *Stigmodera piliventris* Saunders.—24 Nov.-26 Dec., few. C, X, 22, 29.
- * *Stigmodera praetermissa* Carter.—30 Dec.-4 Jan., few. X, 29, 33.
- * *Stigmodera pulchripes* Blackburn.—30 Dec., rare. Y, 29.
- * *Stigmodera quadrifoveolata* Obenberger.—27 Oct.-29 Dec., few. C, C1, X, Z, 22, 29, 35.
- * *Stigmodera rectifasciata* Saunders.—17 Nov.-11 Jan., common. L, X, Y, 29, 33.
- * *Stigmodera rotundata* Saunders.—13 Nov.-4 Dec., common. C, 22, 29.
- * *Stigmodera rufipennis* (Kirby).—27 Oct.-30 Dec., common. C, C1, J, V, Y, Z, 22, 26, 29, 34, 35.
- * *Stigmodera scalaris* (Boisduval).—27 Oct.-29 Jan., common. A, C, C1, K, L, M, P, U, V, X, Z, 3, 22, 28, 29, 34, 35.
- * *Stigmodera semicincta* Laporte & Gory.—14 Jan., rare. U, 34.
- * *Stigmodera sexguttata* Macleay.—13 Nov.-16 Dec., common. C, J, 22, 23, 29, 34.
- * *Stigmodera sexplagiata* Gory.—6 Oct.-13 Jan., common. B, C, C1, I, L, M, N, O, V, W, X, Z, 3, 22, 27, 28, 29, 30, 31, 35, 51.
- * *Stigmodera skusei* Blackburn.—6 Dec.-28 Jan., few. B, C, Q, V, X, Z, 24, 28, 29, 30, 33, 34, 49.
- * *Stigmodera spilota* Laporte & Gory.—6 Dec.-22 Jan., few. C, C1, Q, 22, 29.
- * *Stigmodera spinolae* Gory.—27 Nov.-29 Dec., rare. E, Z, 29.
- * *Stigmodera subgrata* Blackburn.—4 Dec., rare. Y, 29.
- * *Stigmodera subpura* Blackburn.—27 Oct.-16 Dec., common. C1, E, 22, 28, 29, 35.
- * *Stigmodera terminalis* Kerremans.—31 Dec.-22 Jan., rare. I, Q, 22, 29.
- * *Stigmodera thomsoni* Saunders.—30 Dec.-13 Jan., few. W, X, 29, 34.
- * *Stigmodera tricolor* (Kirby).—17 Nov.-23 Feb., common. I, L, M, N, 3, 22, 27, 28, 29, 35.
- * *Stigmodera undulata* (Donovan).—13 Nov.-31 Dec., common. A, B, C, Z, 22, 29, 34.
- * *Stigmodera variopicta* Thomson.—30 Dec.-13 Jan., few. U, X, 29, 33, 34.
- * *Stigmodera vicina* Saunders.—27 Oct.-21 Jan., few. C, C1, X, 22, 28, 34.
- * *Stigmodera victoriensis* Blackburn.—30 Dec., rare. Z, 29.
- * *Stigmodera* sp. No. 1.—8 Dec., rare. X, 34. Similar in colour to *S. sexplagiata* but with elytra strongly acuminate and possibly an aberration of that species.
- * *Stigmodera* sp. No. 2.—30 Dec., rare. Y, 29. Similar to *S. sexplagiata* but is readily distinguished by its highly polished bronze pronotum and bronze ventral surface.
- * *Stigmodera* sp. No. 3.—30 Dec., rare. X, 33. Close to *S. kershawi* and a possible aberration of that species.

Subfamily Chalcophorinae

- Cyria imperialis* (Fabricius).—11 Dec.-21 Jan., few. C, U, X, 2, 34.
- Iridotaenia albivittis* Hope.—30 Dec.-12 Jan., rare. X, 27.

TABLE 3

Summary of data derived from The Australian Museum and Henry Schrader Collections. [Species not encountered by the present authors or appearing in Hawkeswood (1978) or Nikitin (1979)].

Subfamily Buprestinae

- Alcinous nodosus* Kerremans.—National Park, 27 Jan. 1934; Otford, 31 Dec. 1962.
- Ethon latipennis* (Macleay).—Sydney.
- Cisseis rubicunda* Kerremans.—Blue Mountains.
- Cisseis viridiceps* Kerremans.—Northbridge, Nth. Sydney, Dec. 1914; Enfield, 27 Nov. 1910; Abbotsfield.

- Paracephala thoracica* Kerremans.—Pt. Hacking, 3 Jan. 1926.
Prosopheres aurantiopictus Laporte & Gory.—Sydney, 17 Mar. 1941; Mt. Irvine, 14 Mar. 1941.
Xyrosceles crocata Laporte & Gory.—Woy Woy.
Astraeus jansoni Van de Poll.—Blue Mountains (noted in Carter 1933 but probably confused with *A. dilutipes*).
Nascioides carissima Waterhouse.—Cooks River, 11 Oct. 1913, Oct. 1913 and Oct. 1914 on *Acacia longifolia*.
Nascioides costata Carter.—Mt. Wilson, 10 Jan. 1963.
Nascio xanthura Laporte & Gory.—Asquith.
Melobasis semisuturalis miranda Kerremans.—Sydney, Sep. 1931.
Melobasis splendida splendida (Donovan).—Sydney.
Anilara deplanta Thery.—Sydney.
Anilara pagana Obenberger.—Kurrajong, 25 Jan. 1913 on leaves of dying *Eucalyptus*; Sydney.
Notographus sp. Thomson.—Sydney; Blue Mountains.
Stigmodera goryi Laporte & Gory.—Lakemba, Feb. 1923; Enfield, 18 Jan. 1910; Glebe, 10 Oct. 1931; Chatsworth.
Stigmodera praeterita Carter.—Wahroonga; Ku-ring-ai, 1923; Mona Vale, 2 Dec. 1923.
Stigmodera sexmaculata Saunders.—Upper Colo River, 10 Dec. 1936.
Stigmodera vitticollis Macleay.—Kingswood, Mar. 1964.
Stigmodera abdominalis Saunders.—Como.
Stigmodera coeruleipes Saunders.—Wahroonga; Blue Mountains.
Stigmodera cupida Kerremans.—Parramatta.
Stigmodera cydista Rainbow.—Sydney, 5 Oct. 1919; Pt. Hacking.
Stigmodera delta Thomson.—Waterfall.
Stigmodera erythromelas (Boisduval).—Parramatta.
Stigmodera inconspicua Saunders.—Dobroyd Pt, 14 Dec. 1923; Waterloo Swamps, Sydney, 1889.
Stigmodera insignis Blackburn.—La Pouse.
Stigmodera luteocincta Saunders.—Parramatta.
Stigmodera maculifer Kerremans.—Ryde, Dec. 1929.
Stigmodera maculipennis Saunders.—Comara, 1 Nov. 1924.
Stigmodera producta Saunders.—Dobroyd Pt. 14 Dec. 1923. Sydney, 1 Dec. 1928; Cheltenham, 7 Dec. 1975 on *Angophora hispida*.
Stigmodera punctatissima Saunders.—Sydney, Oct. 1913; Enfield, 14 Nov. 1903.
Stigmodera rubriventris Blackburn.—Penrith. Sydney.
Stigmodera septemguttata Waterhouse.—Sydney, Dec. 1911.
Stigmodera simulata Laporte & Gory.—Maroubra; Ropes Creek.

Subfamily Chalcophorinae

- Diadoxus erythrus* White.—Wentworth Falls, Dec. 1940; George Street, Sydney, 30 Oct. 1940.

Discussion

A minimum of 180 species of Buprestidae are therefore known from the central and western areas of the Sydney Basin and of these, 143 species (or 80%) are here listed as recent records dated over the last decade.

The considerable alienation of the Cumberland Plain since settlement would be expected to have had a marked quantitative effect on species numbers but any attempt to elucidate any qualitative change fails in the absence of early recorded data. Carter (1933) recounts the destruction of collecting habitats in the inner Sydney area once frequented by him but gives little indication of the

species reduction. He mentions (Carter 1933: 21) that more than 100 species are to be found within the Sydney postal district (which would have excluded the adjoining Blue Mountains). This number, allowing for synonyms, is not too removed from our own total.

Regardless of their status prior to settlement, a number of species are presently considered rare within the Sydney Basin. The more noteworthy are *Stigmodera armata*, *S. neglecta*, *S. cydista*, *S. affinis* and *S. goryi*. Some evidently are quite local (e.g. *S. balteata*) and a number rarely encountered may, in some seasons, be more commonly found (e.g. *S. limbata*, *S. grandis*). At least one species may be locally extinct; *Nascioides carissima* was recorded from the Cook's River on *Acacia longifolia* but despite an intensive search has not been found in recent years. Some possibly important refuge areas for buprestids within the near Sydney area, not visited are Lane Cove River Park, Sydney Harbour National Park and several council reserves.

Forty five adult food plant species are recorded by us (Table 1). In addition Hawkeswood (1978) lists a further thirteen species; *Casuarina torulosa* Ait., *C. nana* Sieb. ex Spreng., *Themeda australis* (R.Br.) Stapf., *Acacia linifolia* (Vent.) Willd., *Leptospermum phyllicoides* (A.Cunn. ex Schau.) Cheel, *Angophora floribunda* (Sm.) Sweet, *A. bakeri* C. Hall, *Eucalyptus piperita* Sm., *Bursaria spinosa* (Cav.) Druce, *Cassinia compacta* F. Muell., *C. incata* A. Cunn. ex DC., *Banksia spinulosa* Sm., and *Dodonaea triquetra* Wendl. Nikitin (1979) lists *Banksia serrata* L.f. and *Melaleuca styphelloides* Sm. and Froggatt (1892), *Pultenaea stipularis* Sm.

The Gymnosperms are poorly represented; the most interesting association with these being Carter's record of *Xyrosclis crocata* from *Macrozamia* sp. (Carter 1933). This buprestid is apparently rare as Mr C. E. Chadwick (pers. comm.), in a lengthy study of insect/*Macrozamia* associations has not yet encountered this beetle. Carter (1933) also refers to *Diadoxus erythrurus* occurring on introduced pines but we did not take this species. It is apparently a species found inland on native *Callitris* pines.

Our observations have shown that very few adult buprestids are specific at the plant species level. At the family level *Ethon* appears restricted primarily to the Fabaceae as well as some species of *Melobasis* and *Cisseis*. With the onset of summer, however, *Cisseis* occur readily on a number of plant families, particularly the Myrtaceae (*Leptospermums*) and the Mimosaceae (*Acacias*). *Melobasis* may readily be found on *Acacia* but, with our experience, more often outside of the study area.

The Myrtaceae unquestionably dominate the food plants recorded, both in actual plant species numbers and the biomass of buprestids encountered upon them. *Stigmodera* occur periodically in very high numbers and may play a significant pollinator role within this plant family as we have seen large amounts of pollen adhering to many of the beetles examined. Fossil evidence suggests that beetles have played an important role in the pollination of plants (Matthews 1976) and our study indicates that this role is continued within the Myrtaceae

by *Stigmodera*. The *Stigmodera* would appear, from their preference for species of the Myrtaceae, to be oligolectic at the family level. A similar situation is apparent in Australian bees where they are generalistic feeders within the Myrtaceae but where the occurrence of a narrower oligolecty has not been verified (Michener 1970).

One aspect of plant morphology in particular would appear to further support the pollinator role of flower-frequenting *Stigmodera*. Most Myrtaceae have dish-like, shallow flowers. The flower-frequenting buprestids are not structurally equipped to efficiently exploit flower species with tubular blossoms (Matthews 1976) and this would probably explain the relative paucity or absence of *Stigmodera* on many plant species with this type of floral morphology. Armstrong (1979) lists a minimum of 28 Coleoptera and 44 Diptera families as containing anthophilous species and notes that the Australian bee fauna is exclusively flower-frequenting. Although a diverse invertebrate pollinator array frequently can be observed in Myrtaceae communities of the Sydney region, their aggregate biomass often is exceeded by that of *Stigmodera* alone. Ants, which at times can be numerous on blossoms, are viewed by us as "nectar-thieves" (as defined in Heinrich and Raven 1972) for our observations would suggest that the ants tend to restrict their visits to individual flowers and therefore may reduce the outcrossing success of that plant (though their visits to single flowers may actually facilitate pollination in "self-compatible" plants). Where buprestids and bees would alight on a plant and actively clamber from flower to flower and eventually fly to adjoining plants ants were observed to feed primarily from a single flower and then return with this energy reward to their nest.

A further energy enticement may be operative within some of the genera of Myrtaceae encountered. The relatively large, dish-like, flowers of *Leptospermum*, *Angophora* and *Eucalyptus* species may act as small solar reflectors creating a microhabitat sympathetic to a minimum energy expenditure by the buprestid pollinator while it is feeding. Such a situation occurs in the northern hemisphere where flowers of the family Rosaceae are an energy source to pollinators and provide a microclimate that should reduce the energy expenditure for endogenous heat production in the pollinators (Heinrich and Raven 1972). Pollinators may seek to optimize such a regime by basking and though many *Stigmodera* exhibited, at times, little movement (which could be interpreted as basking) this motionless state, alternatively, may have been a reaction by the beetle to our presence. Thus, while feeding or moving across blossoms, and coupled to the high nectar production rate of these three plant genera, a high energy incentive may be offered to the beetles. The high numbers of beetle pollinators that seasonally can be observed could at least be explained in direct response to the caloric reward from the standing food crop and the staggered emergence times of *Stigmodera* species (Table 2 and our unpublished data) could, in part, be viewed as a means of lessening the competition for that energy resource.

A noticeable successional flowering by representatives of four plant genera, *Kunzea ambigua*, *Leptospermum flavescens*, *Angophora hispida* and several

Eucalyptus species, was observed at the Heathcote Road and Royal National Park study sites (*Kunzea ambigua* flowering by late October, *Leptospermum flavescens* by mid November, *Angophora hispida* by late November and *Eucalyptus* species by mid December). There is, however, a variable degree of overlap, at times quite lengthy. Buprestidae noticeably progress from species to species as the season advances. This staggering of flowering is probably explained as a strategy by which the various species compete for the pollinator array available at any one time. Pollination success, within this Myrtaceae assemblage, would be increased and the need for pollinator competition by the plants reduced if the different species in the potential energy crop staggered their flowering times (Heinrich and Raven 1972, Matthews 1976). Failure by a member of such a flowering sequence to produce adequate blossoms could result in pollinator mortality and loss of fecundity. The resulting reduction in pollinator numbers would have a consequential effect on the reproductive potential of those plants flowering later in the sequence (Waser and Real 1979).

Large numbers of flower-frequenting buprestids occurring on one or a small number of plants of the same species, but not on surrounding individuals of that same plant species, may be due to intra-specific staggering of flowering by individual plants. This is often most evident in stands of *Angophora hispida* where individual plants progressively appear "well-trodden". The resulting clines in energy reward are evidently acted upon by beetles in the pollinator array. A pheromone response initiated by female buprestids and acted upon by their conspecific males may be partly responsible for these beetle clusterings but a random count of all species present at Heathcote Road and Mt. York revealed that females were never outnumbered by males.

Angophora hispida and *Leptospermum flavescens* respond to periodic habitat disturbance (such as the rough grading of roadside nature strips) and readily re-establish to form almost monospecific stands. These are maintained for some years, but gradually break up under increasing pressure from incoming colonizers slowly establishing themselves. These monospecific or species poor stands are seasonally frequented by large buprestid assemblages both high in numbers of individuals and species. The energy resources concentrated by plants in such stands may allow clustering of buprestids of low population numbers. Where plants occur as widely scattered individuals encounter frequency in such buprestid species would be low.

From the results of random foliage sweeps some habitat displacement was evident between three of the genera associated with *Casuarina* spp. (viz: *Germarica*, *Astraeus* and *Paracephala*). *Astraeus* seemed to prefer tall woodland to sclerophyll forest; *Paracephala* was consistently found in low open woodland and only on one occasion was a specimen taken in conjunction with *Astraeus*. Species of *Astraeus* were found to coexist as were species of *Paracephala*. *Germarica* was displaced to varying degrees by *Paracephala* at some sites but could be taken commonly in association with *Astraeus*. *Germarica* attained greatest abundance

in sclerophyll forest dominated by *Casuarina* or where *Casuarina* occurred as pure stands. Only at Lapstone were four *Casuarina*-associated genera taken together; *Astraeus* (2 spp.), *Anilara* (1 sp.), *Germanica* (1 sp.) and *Paracephala* (1 specimen only). Studies of niche partitioning would be interesting.

With the encircling national parks, water catchment areas and Commonwealth military reserves forming an almost continuous belt about Sydney's perimeter, the region's Buprestidae would presently appear reasonably protected. However, reserves are small in the western half of the Cumberland plain and the survival of many species in that area is not ensured. Fires which consistently ravage these reserves pose a perceptible threat. It is worth noting that since 1977 many of the sites most rich in buprestid species have been severely burnt. Australian sclerophyll communities are generally believed to have evolved in association with, and as a consequence of, fire but there is no evidence to suggest that these fires were anything more than infrequently occurring events.

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NEW DISTRIBUTION RECORDS FOR SOME QUEENSLAND BUTTERFLIES

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Abstract

Ocybadistes flavovittatus flavovittatus (Latreille), *Suniana sunias nola* (Waterhouse), and *Prosotas felderi* (Murray) are recorded from the Maryborough district, Queensland. This locality forms an important extension to the known distribution of each species.

Introduction

The butterfly species listed below were taken in the Maryborough district, south-eastern Queensland, during November and December 1981. These records form important extensions to the known distribution of the species concerned. All specimens are in the author's collection.

Hesperiidae

Ocybadistes flavovittatus flavovittatus (Latreille)

This southern subspecies has been recorded as far north as the Nambour district, south-eastern Queensland, while the northern subspecies, *O. f. ceres* Waterhouse is known to occur as far south as Yeppoon (Common and Waterhouse, 1981). On several occasions *O. f. flavovittatus* adults were taken flying in grassy areas in Maryborough township. Near Aramara, about 40 km west of Maryborough, males were found flying abundantly with *Taractrocerina* (Waterhouse), amongst grass in a scrubby habitat. A single male and a comparatively worn female were also taken near the foreshore at Urangan on 7 December 1981. Urangan is now the northern known locality for the nominal subspecies, extending its known range by approximately 150 km.

Suniana sunias nola (Waterhouse)

At Rainbow Beach, near Gympie, a freshly emerged male was taken as it rested on a native grass growing in coastal rain forest. Noosa was previously recorded as the most northern locality for this subspecies (Common and Waterhouse, 1981).

Lycaenidae

Prosotas felderi (Murray)

A single male was taken flying in rain forest along the Mary River at Maryborough. Gympie was the former most northern known locality (Common and Waterhouse, 1981).

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THE OCCURRENCE OF *OGYRIS* (LEPIDOPTERA: LYCAENIDAE) IN EMPTY SATURNIID COCOONS

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Abstract

Ogyris ianthis Waterhouse and *O. olane ocela* Waterhouse were recovered from empty cocoons of the moth *Antheraea loranthe* Lucas (fam. Saturniidae) near Leyburn, south-eastern Queensland. Two other species of *Ogyris*, *O. barnardi* Miskin and *O. amaryllis* Hewitson have previously been recorded sheltering in empty saturniid cocoons.

Ogyris ianthis Waterhouse is one of the several *Ogyris* species inhabiting the dry sclerophyll forest areas around Leyburn, south-eastern Queensland. In spring 1979, Stephen Johnson pointed out a Eucalyptus from which he had recovered *O. ianthis* pupae from beneath bands placed on the trunk of the tree. The eucalypt was heavily infested with mistletoe and the ant which attends *O. ianthis* larvae, *Froggattella kirbyi* (Lowne), was present in large numbers.

The tree was revisited in late January, 1980. While searching high in the tree, approximately six metres from the ground, many *F. kirbyi* were noticed around a 'clump' of empty saturniid cocoons. The cocoons were situated at the base of the mistletoe *Amycma miquelii* (Lehm. ex Miq.) Tiegh and the ants were entering the emergence holes left by the adult moths.

The cocoons were formed by larvae of *Antheraea loranthe* Lucas (fam. Saturniidae) which feed on mistletoe and become gregarious when spinning their cocoons. The clump of cocoons was removed from the base of the mistletoe and taken to Brisbane. Partial examination revealed the presence of a fourth instar *O. ianthis* larva (Fig. 1), so the cocoons were placed in a plastic bag with mistletoe obtained from the host tree.



Fig. 1. Fourth instar larva of *Ogyris ianthis* found sheltering in empty saturniid cocoons at Leyburn, January, 1980.

From January 28th to February 12th, four males and five females of *O. ianthis* emerged from the cocoons as well as a female of *O. olane ocela* Waterhouse. Although there were approximately 14 empty saturniid cocoons in the clump, inspection revealed that most of the *Ogyris* pupae were located in only four. These few cocoons had their openings near the point of attachment to the mistletoe base and this position would have allowed easy access to the food plant. Inspection also revealed the presence of three *O. ianthis* larvae parasitised by braconid wasps.

Two other *Ogyris* species are known to shelter in empty saturniid cocoons. Le Souef (1977) found the larvae and pupae of *O. barnardi barnardi* Miskin, *O. amaryllis amaryllis* Hewitson and *O. a. meridionalis* Bethune-Baker sheltering in the cocoons of *Antheraea engaea* Turner, another moth that feeds on mistletoe.

Acknowledgements

I wish to thank Mr S. J. Johnson and Dr J. A. Graff for their assistance, and L. Jessop and Dr H. T. Clifford, Department of Botany, University of Queensland, for identification of the mistletoe.

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A FOOD GATHERING STRATEGY OF THE BLACK JUMPER ANT *MYRMECIA PILOSULA* (SMITH) (HYMENOPTERA: FORMICIDAE)

By N. H. Morrison

14 Tarraleah Cres., Lyons, A.C.T. 2606

The black jumper ant, *Myrmecia pilosula* (Smith) is an active aggressive ant which is abundant in the Australian high country.

In December 1981, at Sawpit Creek in Kosciusko National Park, a worker of this species was observed sitting motionless on the petals of a *Brachycome* daisy. This was so unusual that it was decided to try to photograph it. While still observing the ant through the viewfinder a small flowerfly landed on the yellow centre of the flower. The ant instantly jumped at the fly and simultaneously arched its body to sting it. The ant proceeded to carry the fly over the side of the flower, pausing once to sting the still feebly struggling fly before moving under the petals to the stem.

There was little doubt that the ant had been lying in wait for prey and, having been alerted to this behaviour, a watch was kept on other plants during the rest of the walk. Many ants were seen but only one other was observed waiting on a flower. Thus, it appears that an ambush technique is a food gathering strategy which is occasionally used by this species.

Acknowledgement

I would like to acknowledge the assistance of Dr R. W. Taylor, C.S.I.R.O., Division of Entomology, Canberra, who confirmed the identification of the species.

NEW FOOD PLANTS, LIFE HISTORY NOTES, AND DISTRIBUTION RECORDS FOR SOME AUSTRALIAN LEPIDOPTERA

By Murdoch De Baar

25 Irwin Terrace, Oxley, Queensland, 4075

This paper records food plants, life history notes and distribution records on butterflies and moths, in addition to those given by Common (1963), Common (1970) and Common and Waterhouse (1981).

PYRALIDAE: PYRAUSTINAE

Pyrausta incoloralis (Guenée)

Asclepias fruticosa L., *Secamone elliptica* R. Br., *Ischnostemma* (*Cynanchum*) *carosum* (R. Br.) Merr. & Rolfe (Asclepiadaceae). Larvae were reared during February, March and April 1981 in the Brisbane area, Queensland.

HESPERIIDAE

Ocybadistes walkeri sothis Waterhouse

Panicum maximum Jacq. (Poaceae). A larva fed on this grass during July 1981 at Brisbane, Queensland.

Arrhenes dschilus iris (Waterhouse)

An adult was collected on 8 October 1981, 10 km south of Sarina, Queensland. This species has not previously been recorded south of Mackay, Queensland (Common and Waterhouse, 1981).

Pelopidas agna dingo Evans

Ischaemum australe R. Br. (Poaceae). Eggs and larvae were collected on *I. australe* during April 1981 near Toorbul, Queensland. Larvae accepted *Panicum maximum* Jacq. (Poaceae) and were reared to maturity.

PAPILIONIDAE

Protographium leosthenes leosthenes (Doubleday)

Two larvae collected from Canungra, Queensland, pupated during mid January 1980. One adult emerged on 24 March 1981, after 14 months as a pupa. The second pupa discoloured between 13-20 October 1981 and died after 21 months as a pupa.

PIERIDAE

Eurema laeta lineata (Miskin)

Several adults were collected on 8 October 1981, 25 km south of Carmila, and on 10 October 1981, 50 km south of St Lawrence, central Queensland. This species has not previously been recorded south of the Paluma Range, Queensland.

NYMPHALIDAE

Melanitis leda bankia (F.)

Panicum maximum Jacq. (Poaceae). Larvae fed on this grass during March and April 1981 at Brisbane, Queensland.

Pantoporia consimilis consimilis (Boisduval)

Several adults were collected on 8-10 October 1981, 50 km south of Sarina, Queensland. This extends the known distribution of this species southwards from Mackay, Qld.

LYCAENIDAE

Hypochrysops digglesii (Hewitson)

Downey (1966) noted that pupae of many lycaenids are capable of sound production but states the presence of ants is required. I have observed pupae of this species clearly moving abdominal plates 5 and 6 against each other, both in the presence and absence of ants. Pupae were particularly noisy at night, and capable of producing a vibration through the container in which they were held.

Philiris innotata (Miskin)

Adults were collected on 9 October 1981 at Sarina, and 10 October 1981, 50 km south of Sarina, Queensland, where its food plant, *Ficus opposita* (Moraceae), occurs. Further south *Ficus opposita* is also present on many creeks but *P. innotata* could not be found. Subspecies *innotata* and *evinclis* are currently considered geographically separated by the distance between Mackay and Rockhampton.

Ogyris olane ocela Waterhouse

A larva of this species was collected during January 1981 at Leyburn, Queensland. The larva was bred at Brisbane, Queensland, where workers of a local colony of *Plagiolepis alluaudi* Emery, the minute ant, found and attended the larva.

Deudorix epijarbas diovis Hewitson

Cupaniopsis anacardioides Radlk. (Sapindaceae). Larvae were feeding in the fruit during January 1981 at Brisbane, Queensland. Other larval food plants include *Buckinghamia celsissima* (De Baar, 1979), from which adults were bred during June and July 1979.

Rapala varuna simsoni (Miskin)

Buckinghamia celsissima F. Muell. (Proteaceae). An adult was noted ovipositing on the flowers of this tree during December 1980 at Brisbane, Queensland. The flowers persisted until March 1981.

SPHINGIDAE

Hippotion celerio (L.)

Plumeria acutifolia Poir "frangipani" (Apocynaceae). A larva fed extensively on this plant before pupating. The moth emerged on 28 November 1980 at Brisbane, Qld.

Acknowledgements

I wish to thank Dr H. T. Clifford, Botany Department, University of Queensland, Dr G. Guymer and Mr B. Simon, Queensland Herbarium, for identifying plants. I also wish to thank J. A. Hockey and D. J. Toomey for typing the manuscript.

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JOHN CECIL Le SOÛEF, 5 November 1905 – 21 June 1982

One of the great amateur entomologists in Victoria, 'Zoo' Le Souëf, passed away on 21 June 1982 after a period of severe illness. His life-long nickname, acquired through his strong family connection with the Melbourne Zoological Gardens (both his father and grandfather were Directors, and he was actually born on the premises) was singularly apt, and he pursued an interest in natural history, especially insects, throughout his life. Zoo travelled widely in Australia, usually in pursuit of butterflies, and many biologists and friends benefitted from his willingness to pick up any sort of beast en route if he knew of anyone working on the group, and from his unstinting sharing of his captures. His scorpions, for instance, went to the Western Australian Museum, and some have been incorporated into revisions by L. E. Koch. As a result of these trips, and from his active entomological correspondence, Zoo became known (at least by reputation) to most entomologists in Australia and to a wide circle of overseas enthusiasts. In later years his main entomological activity was a study of the lycaenid genus *Ogyris*, of which he had reared many specimens from remote parts of Queensland and New South Wales.

Zoo had long been a major driving force in the Entomological Society of Victoria. He joined the Society in 1941, and the minute book shows that he exhibited and read several notes on Lepidoptera during that year. He was elected Secretary in 1942 but the Society was disbanded late that year because of the war. When the Society was reformed in 1961, it was as a result of a letter sent by Zoo to a circle of entomological friends. His infectious enthusiasm guided the Society through several very lean periods, and many members over the ensuing 20 years will remember his encouragement with both gratitude and affection. Zoo's legacy is a thriving group of entomologists in Victoria, and his own work on Lepidoptera is remembered not only by his publications, together with numerous notes in *Wings and Stings* and the *Victorian Entomologist* (which he edited for several years and sometimes wrote almost singlehanded) but also in the acknowledgements paid him in most books on Australian Lepidoptera published in recent years. He is commemorated by the skipper *Hesperilla crypsargyra lesouefi* Tindale.

Entomology, though, comprised only part of his activity. Amongst Zoo's many community interests, he played a leading role in Rotary and had recently been awarded their prestigious Paul Harris Fellowship. He was also an Honorary Justice of the Peace. Educated at Melbourne Grammar School, Zoo became familiar with the 'outback' by jackerooing as a young man. He and Mary (whom he married in 1941, and who has shared his entomological pursuits during their long partnership) owned a cordial factory at Kyabram until they settled in Blairowrie in 1953, to run the village store. They later founded the well-known Rosebud Aquarium, at present operated by their son, Nick.

Zoo had a strong feeling for people and for entomological tradition, and was a fund of information on both entomologists and insects. Towards the end of his life he sometimes expressed regret that he had not achieved more, such frustration again reflecting his very active mind. To those of us who knew Zoo, and benefitted so much from his knowledge and enthusiasm, he had achieved more than enough to render him one of the most memorable and respected characters associated with our hobby in Australia.

BOOK REVIEW

Insect pheromone technology: chemistry and applications. (American Chemical Society Symposium series, 190). B. A. Leonhardt & M. Beroza, eds. 1982. 8vo. 260 pp, illustr., case bound. Based on the symposium held on Chemistry and Applications of Insect Pheromone Technology, sponsored by the Division of Pesticide Chemistry at the 182nd Meeting of the A.C.S., New York. American Chemical Society, 1155 Sixteenth St., N.W. Washington, D.C. 20036, U.S.A. Price US\$43.95.

This fourteen-chapter volume explores recent findings of foremost authorities in insect pheromone research. Fields of interest discussed are broad and include advances in isolation, identification, synthesis and application of pheromones.

At the risk of appearing biased I list the titles of just four of the papers presented: Analysis of Chemical Communications Systems of Lepidoptera; Some Aspects of the Synthesis of Insect Sex Pheromones; Release Rates of Pheromones from Hollow Fibres; Challenges in the use of Pheromones for Managing Western Forest Lepidoptera.

Those who have followed the pheromone field will know that there have been tremendous advances in pheromone technology in recent years and this title is an attempt to update. The papers are of a high standard summarizing results of international significance. I feel the book is of major consequence for agricultural entomologists, insect physiologists and others concerned with insect pheromones.

M. S. MOULDS

AN ACCUMULATIVE BIBLIOGRAPHY OF AUSTRALIAN ENTOMOLOGY

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KEYS TO PRINCIPAL FAMILIES

The following keys have been constructed solely for the practical purpose of identifying the principal families of beetles to be found in the south-eastern States and the arrangement employed does not necessarily indicate true relationships (some families appear in several places). Families with no representative of a length greater than 3 mm, in the region, have been excluded, as have certain others that for reasons of rarity or obscure habits are unlikely to attract the notice of the beginner. The keys should therefore be used with reserve for smaller specimens (which may or may not belong to the families covered) or for any collected elsewhere in Australia. Species found in the nests of ants or termites will also call for caution as these frequently show reduced tarsal segmentation and/or other gross modifications that will defeat the keys.

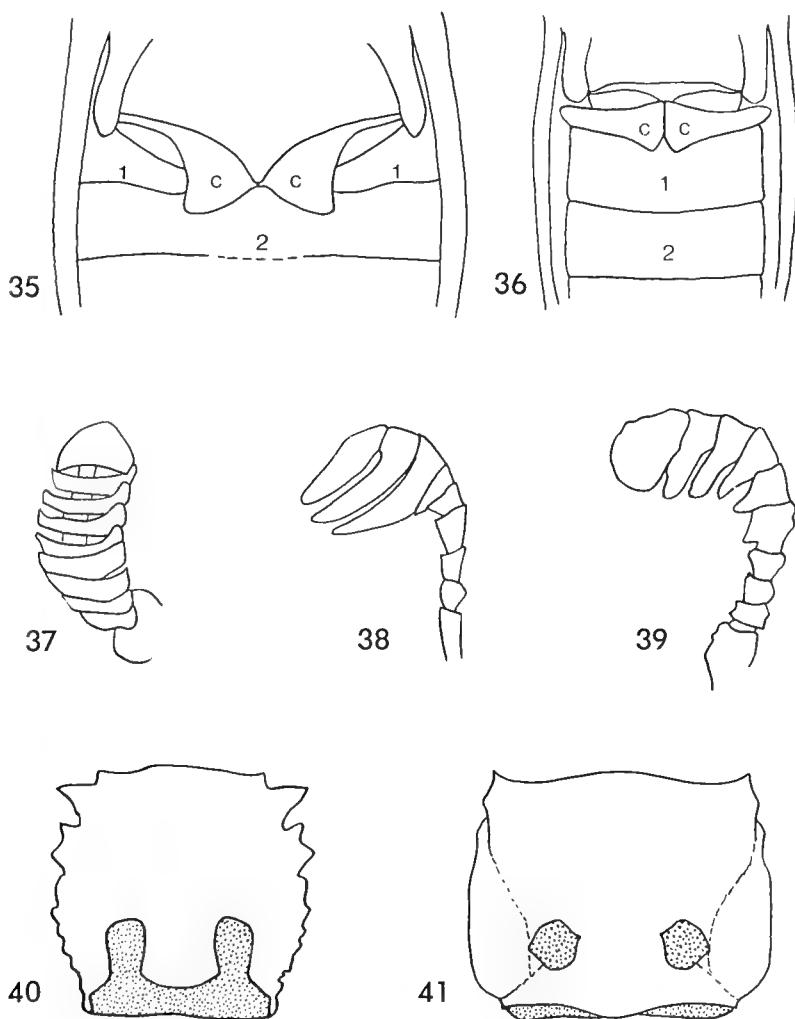
To use the keys, take the first couplet and select the alternative that better fits the specimen, then proceed to the couplet indicated by the right-hand number; repeat the process until a family name is reached and then *check the specimen against the description and figures given for that family in this systematic section*. In cases of doubt or of unsatisfactory outcome, try both alternatives at uncertain couplets.

1. Front tarsi clearly 5-segmented 2
- Front tarsi actually or apparently with fewer than 5 segments 3
2. Hind tarsi with only 4 segments SECTION 3
- All tarsi clearly 5-segmented SECTION 1
3. All tarsi actually or apparently with 4 segments SECTION 4
- All tarsi actually or apparently with only 3 segments SECTION 2

SECTION 1

1. Aquatic beetles, with hindlegs (and sometimes also middle legs) modified for swimming 2
- Terrestrial (or sometimes, semi-aquatic) beetles, without modifications for swimming 4
2. Middle and hindlegs forming very short paddles; eyes divided by margins of head; surface swimmers GYRINIDAE
- Middle and hindlegs of normal length; eyes entire 3
3. Antennae short, clavate; palpi longer than antennae HYDROPHILIDAE
- Antennae longer, filiform; palpi much shorter DYTISCIDAE
4. First ventral segment (sternite) of abdomen completely divided by hind coxae (Fig. 35) 5
- First ventral segment of abdomen not completely divided (Fig. 36)

5. Antennae short, thick, moniliform (Fig. 3); mandibles small, covered by labrum; pronotum deeply grooved; slow-moving beetles associated with dead wood. RHYSODIDAE
- Antennae normally longer, slender, filiform *or* submoniliform (but grossly expanded in Paussini, Fig. 37); mandibles usually large and prominent; pronotum seldom deeply grooved; mostly agile predators CARABIDAE
6. Elytral sculpture lattice-like, with well marked meshes 7
- Elytra otherwise sculptured or smooth 8
7. Elytra closely adapted to hindbody and meeting along suture; antennae filiform CUPEDIDAE
- Elytra poorly adapted to hindbody, more or less divergent; antennae serrate or pectinate LYCIDAE
8. Antennae with terminal segments lamellate *or* serrate inwardly; front tibiae dentate externally 9
- Not with these features combined 12
9. First (basal) segment of antennae very long, the antennae often geniculate; mandibles usually prominent, especially in males; labrum scarcely apparent LUCANIDAE
- First segment of antennae shorter, the organs never geniculate; mandibles short, nearly covered by an obvious labrum 10
10. Antennal laminae closely apposable, forming a distinct club (Fig. 38) 11
- Antennae folding like a fern frond, not obviously clubbed (Fig. 39) PASSALIDAE
11. Head deflexed; sculpture irregular and strongly rugose; pygidium always covered by elytral apices TROGIDAE
- Head not deflexed; sculpture seldom strongly rugose; pygidium usually exposed (except in Geotrupinae). SCARABAEIDAE
12. Elytra very short, leaving at least three abdominal segments exposed 13
- Elytra longer, covering all *or* most of abdomen 15
13. Underwings exposed at all times; very slender beetles . LYMEXYLIDAE
- Underwings covered by elytra, except in flight 14
14. Abdomen strongly armoured STAPHYLINIDAE
- Abdomen soft MELYRIDAE
15. Apex (pygidium) of abdomen exposed 16
- Apex of abdomen covered by elytra 19
16. Antennae geniculate and roundly clavate HISTERIDAE
- Antennae not geniculate 17



Figs 35-41. Key characters. (35) abdominal sternite 1 completely divided by hind coxae (c) (Carabidae, *Rhytisternus*); (36) abdominal sternite 1 not divided (Cupedidae, *Cupes*); (37) expanded antenna of Carabidae Paussini (*Arthropterus*); (38) clavate-lamellate antenna of Scarabaeidae (*Onthophagus*); (39) lamellate antenna of Passalidae (*Pharochilus*); (40) open procoxal cavities of Cucujidae (*Uleiota*); (41) closed procoxal cavities of Prostomidae (*Prostomis*).

SECTION 2

1. Elytra short, exposing at least 3 abdominal segments; tarsi: 3-3-3 PSELAPHIDAE
- Elytra covering the entire abdomen; tarsi: 4*-4*-4* 2
2. Tarsal claws angled or toothed beneath (Fig.15); antennae very short COCCINELLIDAE
- Tarsal claws simple; antennae longer ENDOMYCHIDAE

SECTION 3

1. Underside of prothorax with cavities for reception of the antennae; large (25 - 35 mm), tuberculate beetles ZOPHERIDAE
- Prothorax without such cavities 2
2. Exceedingly flat, subcortical beetles CUCUJIDAE
- Convex beetles 3
3. Tarsal claws pectinate beneath 4
- Tarsal claws simple 5
4. Head constricted into a pronounced neck MELOIDAE
- Head much less constricted behind ALLECULIDAE
5. Penultimate tarsal segment strongly expanded and bilobed beneath . . 6
- Penultimate tarsal segment simple 9
6. Head constricted into a pronounced neck ANTHICIDAE
- Head not greatly constricted behind 7
7. Elytra broadly oval, much wider than the foreparts LAGRIIDAE
- Elytra subparallel, not much wider than the foreparts 8
8. Antennae short, loosely clavate; pubescence coarse CLERIDAE
- Antennae long, filiform; pubescence fine or absent . . OEDEMERIDAE
9. Head deflexed; abdomen projecting beyond the elytra as a long point MORDELLIDAE
- Head not deflexed; abdomen not markedly pointed, normally covered by the elytra 10
10. Head with a pronounced neck; ant-like beetles ANTHICIDAE
- Head not markedly constricted behind; stout, heavily armoured beetles TENEBRIONIDAE

SECTION 4

1. Head with a distinct rostrum, which carries the antennae; mouthparts reduced; tarsi 5*-5*-5* 2
- Head seldom with a rostrum, the latter, if present, not carrying the antennae; mouthparts all clearly visible 5
2. Antennae geniculate or with the first (basal) segment as long or longer than the next 3 combined CURCULIONIDAE
- Antennae never geniculate; the first segment relatively much shorter . . 3

3. Palpi normal and flexible; labrum distinct and free. . . ANTHRIBIDAE
 — Palpi very short and rigid (often invisible); labrum not apparent . . . 4
4. Antennae filiform but thicker near apex. BELIDAE
 — Antennae moniliform, not markedly thicker apically . . BRENTHIDAE
5. Antennae distinctly clavate. 6
 — Antennae not clavate. 11
6. Antennae very short; tarsi 4-4-4. HETEROCERIDAE
 — Antennae much longer. 7
7. Antennae stout, strongly moniliform; tarsi 5*-5*-5*. PASSANDRIDAE
 — Antennae much more slender 8
8. A pair of long bristles present between the tarsal claws; tarsi 5*-5*-5* TROGOSITIDAE
 — Claws without intervening bristles 9
9. Antennae shorter, usually inserted under the marginal ridge; tarsi 4-4-4 COLYDIIDAE
 — Antennae longer, the insertions visible from above; tarsi 5*-5*-5* . . 10
10. Penultimate segment in all tarsi strongly bilobed beneath. . CLERIDAE
 — Penultimate segment in all tarsi scarcely lobed EROTYLIDAE
11. Flat or elongate, subcortical beetles; tarsi 4-4-4 12
 — Convex beetles; tarsi 5*-5*-5* (penultimate segment small, Fig. 13). 13
12. Front coxal cavities open behind (Fig. 40) CUCUJIDAE
 — Front coxal cavities closed (Fig. 41) PROSTOMIDAE
13. Eyes usually strongly excised and encompassing the bases of the antennae, the latter inserted on frontal prominences and often as long as or longer than the body; first (basal) segment of antennae elongate. CERAMBYCIDAE
 — Eyes usually globular but when excised, not encompassing the antennae, the latter seldom inserted on prominences and usually shorter than the body; first segment of antennae usually short and clavate. CHRYSOMELIDAE



NOTE

Sizes (or size-ranges in variable species) are given in millimetres, in parentheses, for all beetles mentioned in the following descriptive section. These are length measurements and they include the rostrum, if present, and the mandibles if these project forward, but not the antennae.

Family CUPEDIDAE

Tarsal formula: 5-5-5

Antennae: stout, filiform

Medium sized, elongate, slow-moving beetles, with characteristic, lattice-like sculpture (Figs 42, 46), often partly obscured by scales. The meshes of the elytra, which represent the membranous cells of the ancestral wing, are weakly sclerotised and appear translucent by transmitted light.

These are primitive beetles that fossils indicate were a lot more plentiful in Mesozoic times, some 200 million years ago. The family is still almost worldwide but the few remaining species are now localised and mostly rare. The larvae are eruciform and live in rather dry rotten wood.

We have two genera: *Omma* Newman, with short antennae, not extending to the base of the prothorax, and *Cupes* F., where these organs reach well beyond the elytral shoulders. However, some specialists now isolate the former genus in a separate family, the Ommatidae.

Omma mastersi Macl. (7-12 mm) (Fig. 42) is prettily chequered with brownish-black and white scales and is usually smaller than the all-dark *O. stanleyi* Newm. (12-25 mm). *Cupes varians* Lea (10-14 mm) (Fig. 46) is greyish-brown with darker flecks along the ribs and has a tubercle beside each eye, which other species lack. *C. eumana* Neb. (6-7 mm) is greyish-white with black flecks; *C. youngana* Neb. (6-8 mm) and *C. mathesonae* Neb. (7-10 mm) have alternating flecks of brown and buff along the elytral ribs, but these ribs are light at base in the former, dark in the latter. All species are widespread but uncommon; they occur occasionally under bark but most specimens are obtained at light.

When disturbed, *Cupes* species feign death, with the antennae held close together and projecting stiffly forward.



Fig. 42
Omma mastersi Macl.

Family RHYSODIDAE

Tarsal formula: 5-5-5

Antennae: stout, moniliform

Small (4-11 mm), heavily armoured and strongly sculptured, all-black beetles, with stout legs and beadlike antennae. The elytra in all our species bear either deep longitudinal furrows or punctured striae and the pronotum is usually trisulcate. In life, these furrows are always partly filled with dried masses of slime mould, upon which the beetles have been feeding and it seems these reserves serve to inoculate the rotten wood in which they breed. The larvae are eruciform and appear also to feed on slime-mould plasmodium. They and the adults are found mostly in old wet and punky wood that is in the last stages of degeneration.

This is a small but worldwide family whose members all share a highly distinctive general appearance that is soon recognised. They might possibly be confused at first with certain Colydiidae or Passandridae, but in the former the tarsi are 4-4-4 and in the latter 5*-5*-5*. Some workers regard rhyssodids as specialised carabids and place them (as a tribe or subfamily) in that family.

All Australian rhyssodids were at one time included in a single genus, *Rhysodes* Dalman, but a recent world-based generic revision by Bell and Bell (1978) has introduced a number of new names that have greatly modified the appearance of our own list. The four local species may be identified by means of the following key:—

1. Elytra free, regularly punctato-striate; intervals even and lightly convex; underwings present 2
- Elytra soldered together, irregularly striate; intervals alternately elevated and depressed; underwings absent. *Rhyssodiastes burnsi* Oke
2. Median lobe of head long, reaching hind margin and thus separating lateral lobes (Fig. 43). *Kaveinga frontalis* Grouvelle
- Median lobe of head short, not reaching hind margin; lateral lobes contiguous at rear 3

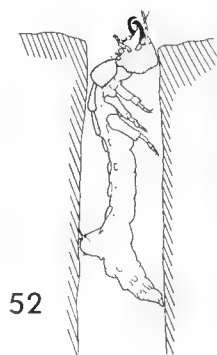
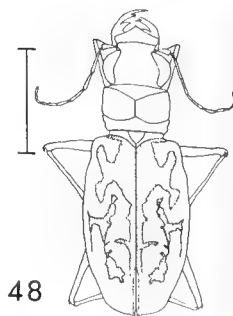
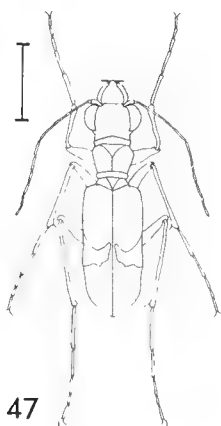
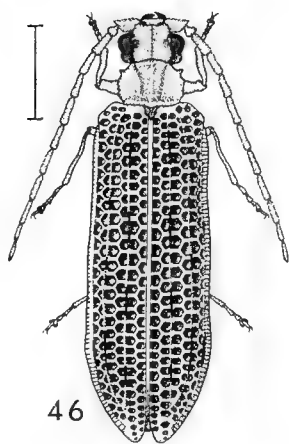
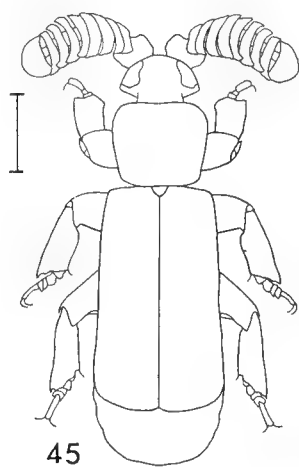
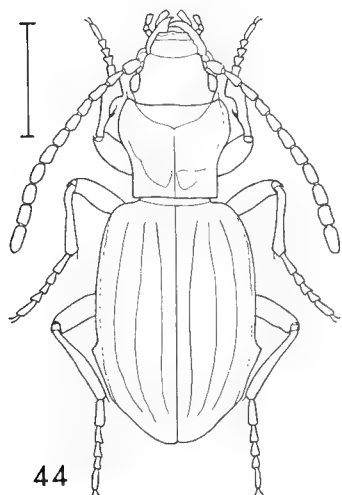


Fig. 43

Kaveinga frontalis Grouv.

3. Pronotum trisulcate. *Leoglymmius lignarius* Olliff
 — Pronotum with only a median sulcus, plus two basal foveae.
 *Yamatosa planata* Lea

Of these species, *K. frontalis* (5.6-7.5 mm) (Fig. 43) appears to be the most widespread, having been recorded from Tasmania, Victoria and New South Wales. *L. lignarius* (7.5-10.5 mm) and *Y. planata* (7.3-8.5 mm) are known from Victoria and New South Wales and the unique type of *R. burnsi* was taken in the Blue Mountains. Eight other species (some of them undescribed) are known from Queensland, mostly from the tropics.



Family CARABIDAE

(Tiger beetles and Ground beetles)

Tarsal formula: 5-5-5

Antennae: slender: filiform or submoniliform
(except in Paussini)

Minute to very large, active, running or burrowing beetles of generally characteristic appearance. Fore tibiae with a notch or groove, serving as an antennal cleaner (except in Paussini and Cicindelinae); hind coxae immovable.

This is a very large family of mainly predacious beetles, with many heavily built, flightless, ground-dwelling forms. The more lightly built species have, however, generally retained their underwings and they fly under warm and humid conditions. Some of the smaller forms are tree-dwellers (arboricoles).

Most carabids emit a highly odorous defensive secretion when roughly handled and in the Paussinae and Brachininae, this is ejected with explosive force. Males of many species may be recognised by their expanded front (and sometimes, also middle) tarsi, with adhesive vestiture beneath; these are used to grasp the female during mating. However, males in a few groups have unmodified tarsi.

Over 30 subfamilies of carabids are recognised in the Australian fauna and most of these are represented in south-eastern Australia, but only the more important and characteristic ones can be considered here (see also Britton, 1970, for a useful key).

Carabid larvae are generally of the campodeiform type (Fig. 84) but a few species with semi-parasitic habits become degenerate in the later instars. The legs normally consist of five segments (coxa, trochanter, femur, tibia and an unsegmented tarsus) and there are usually two tarsal claws.

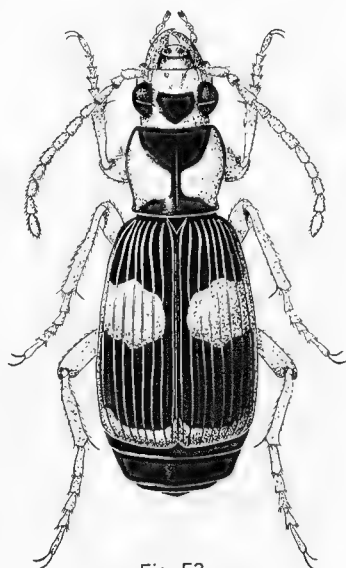


Fig. 53
Pheropsophus verticalis Dej.

Figs 44-52. Cupedidae and Carabidae. (44) *Mystropomus subcostatus* Chaud. (Carabidae, Paussinae); (45) *Arthropterus westwoodi* MacI. (Carabidae, Paussinae); (46) *Cupes varians* Lea (Cupedidae). (47-52) Carabidae, Cicindelinae: (47) *Distipsidera flavicans* Chaud.; (48) *Cicindela ypsilon* Dej.; (49) *Cicindela semicincta* Brullé, right elytron; (50) *C. mastersi* Cast.; (51) *Distipsidera undulata* Westw.; (52) *Megacephala australis* Chaud., larva in burrow.

Subfamily PAUSSINAE: slow moving and dark coloured ground beetles with a 'bombardier' type of defensive mechanism similar to that of the better known Brachininae (*q.v.*). Members of the tribe Paussini have extraordinarily broad antennae (Figs 37, 45) that make them recognisable on sight but the rather numerous species are difficult to identify, although most belong to the one genus, *Arthropterus* MacL. Many exotic species of the tribe are myrmecophiles but species from south-eastern Australia are taken from beneath the bark of standing trees or under fallen logs in open country; they also fly to light at night.

Mystropomus subcostatus Chaud. (13-17 mm) (Fig. 44) is the only member of the tribe Ozaenini in south-eastern Australia; it is a dull black, flightless species of the litter zone in the dense, wet forests of the New England Tablelands and southern Queensland.

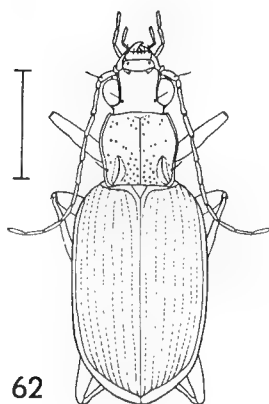
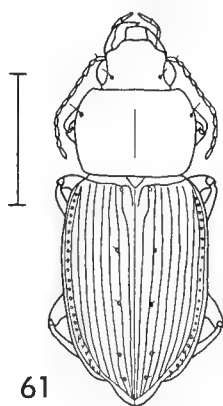
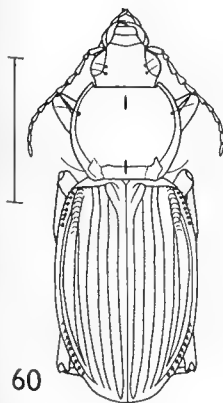
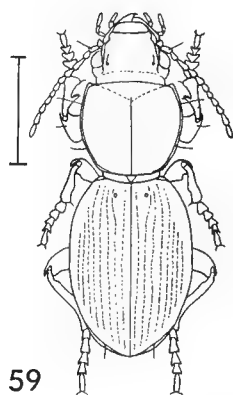
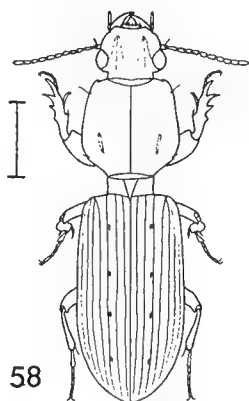
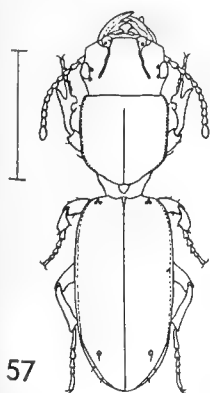
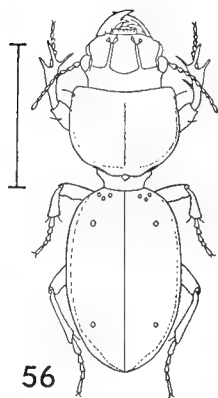
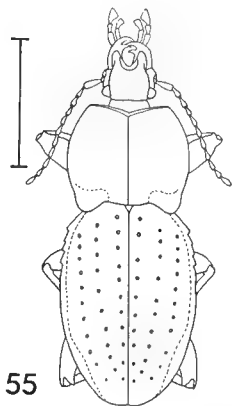
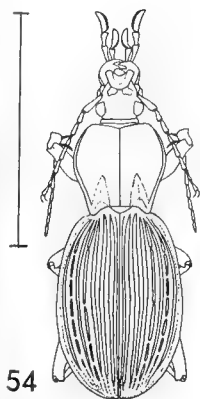
Subfamily CICINDELINAE (Tiger beetles): agile beetles with slender legs, large eyes and characteristically toothed mandibles. Most of the Australian species are tropical but a few extend to the south-eastern States. *Cicindela ypsilon* Dej. (13-15 mm) (Fig. 48), ivory-white with bronze markings, abounds on coastal beaches in early summer, running and flying in the sunshine; *C. mastersi* Cast. (8-11 mm) (Fig. 50), dull brownish-black with white spots, is a late summer species that occurs locally along muddy creek-beds away from the coast. The rather similar *C. semicincta* Brullé (9-12 mm) (Fig. 49) is a widespread oriental species that extends as far south as the Canberra district and is perhaps the commonest of all Australian Tiger beetles. Species of *Distipsidera* live on the trunks of trees in open forest from New England northwards and are rather hard to catch; *undulata* Westw. (12-17 mm) (Fig. 51) and *flavicans* Chaud. (9-11 mm) (Fig. 47) occur within our limits. The mandibles in these arboreal Tiger beetles are almost entirely covered by the large labrum.

Megacephala includes the nocturnal Tiger beetles, many with bright metallic colours; they are mostly insects of the north-western outback but the brilliant green and yellow *M. australis* Chaud. (18-21 mm) is common about salt-pans in the western Riverina.

Tiger beetle larvae are curiously contorted creatures (Fig. 52), entirely adapted to life in a vertical burrow, from which they seize passing prey. The head and prothorax are armoured and together form a shield that protects the soft hindbody below; the latter bears a hump on segment 5, carrying stout hooks that anchor the larva when dealing with struggling prey.

The Australian Tiger beetles belonging to *Cicindela* have been revised recently by Freitag (1979).

Figs 54-62. Carabidae. (54) *Pamborus alternans* Latr.; (55) *P. guerini* Gory; (56) *Carenum bonellii* Westw.; (57) *C. tinctillatum* Newm.; (58) *Clivina australasiae* Bohe.; (59) *Promecoderus mastersi* MacL.; (60) *Sarticus cyaneocinctus* Chaud.; (61) *Gnathaphanus pulcher* Dej.; (62) *Chlaenius darlingensis* Cast.



Subfamily CARABINAE: large metallic Ground beetles with characteristic, securiform (hatchet-shaped) palpi; both Australian genera occur in our region. The widespread *Calosoma schayeri* Er. (22-26 mm) (Fig. 1) is our one local caterpillar hunter (a group better represented in N. America and Europe); it is a broad, bright metallic green beetle that flies at night and often comes to lights in early summer; when handled it gives off a strong musk-like odour (salicylaldehyde); the heavily armoured larva is seldom seen and is probably largely subterranean in habit.

The twelve known species of *Pamborus* are all Australian and five of them occur in our area; they are largely insects of the Dividing Range, from the Shoalhaven River northwards, and are believed to feed on snails. *P. alternans* Latr. (Fig. 54) is a large (28-34 mm), bronze-black beetle, with touches of purple on the thorax and green on the elytra. The latter bear 6-8 low ribs (costae) which are more or less broken into tubercles towards the rear. *P. macleayi* Cast., of the Queensland border area is similar but smaller (21-25 mm). *P. viridis* Gory (25-34 mm) is more markedly metallic green and the elytral ribs are unbroken; it occurs in more open country than the others, on the northern tablelands south to Mt Canobolas, near Orange. Two other species from the wet forests have finer elytral sculpture (13-15 ribs on each): *P. guerini* Gory (15-19 mm) (Fig. 55), shoulders of elytra serrate, hindbody about as long as head plus prothorax; *P. pradieri* Chaud. (23-26 mm), shoulders of elytra smooth, hindbody much longer; both occur in the wet forests of the New England Tablelands.

Larvae of *Pamborus* species are seldom seen but I described that of *P. macleayi* some years ago (Moore 1966); it is a long, slender creature, heavily armoured and with very short urogomphi (Fig. 84); others discovered later prove to be very similar.

Subfamily SCARITINAE: robust, burrowing species, with multidentate fore tibiae; body pedunculate (i.e., prothorax and hindbody separated by a pronounced waist), heavily armoured. This is a large group with many species in the dry, sandy outback, and including some giant forms (genus *Euryscapus*). The dominant genus is *Carenum*, which includes some handsomely metallic species, but few of these penetrate the Great Dividing Range. *C. bonellii* Westw. (17-21 mm) is the commonest near the east coast; it is rather cylindrical in form (Fig. 56) and of a bronzy green, with purplish blue margins; *C. tinctillatum* Newm. (15-20 mm) (Fig. 57) is still more cylindrical

Figs 63-73. Carabidae. (63) *Scaraphites rotundipennis* Dej. (64) *Philoscaphus tuberculatus* Macl. (65) *Percosoma sulcipenne* Bates; (66) *Hyperion schroetteri* Schreib.; (67) *Catadromus australis* Cast.; (68) *Catadromus lacordairei* Boisd.; (69) *Nurus latipennis* Sl.; (70) *Cratoferonia regalis* Cast.; (71) *Trichosternus vigorsi* Gory; (72) *Notonomus triplogenioides* Chaud.; (73) *Castelnaudia superba* Cast. Approximately natural size.



63



64



65



66



67



68



69



70



71



72



73

and is easily recognised by its uniform bright purple colour; it is very widespread. Of the broader, more oval species, we have *C. marginatum* Boisd. (20-24 mm), dull pitchy-black, with bright green margins, Dividing Range from Picton to Wauchope; *interruptum* Macl. (18-26 mm), jet black with purplish margins, each elytron with two small, widely spaced pits, common on the tablelands from Canberra to central Queensland; *laevigatum* Macl. (17-21 mm), similar but elytron with only the apical pit, Tasmania to New England Tablelands; and *elegans* Macl. (16-26 mm), broadly oval and rather depressed, brilliant though variable in colour, the elytra vaguely striate. The last-mentioned is perhaps the most handsome of several outback species that reach our western fringes.

In the related genus *Lacopterum* the elytra are deeply pitted: *L. loculosum* Newm. (15-20 mm), entirely dull black, elytral pits irregularly placed, mallee districts of S.A., Vic. and N.S.W.; *L. foveigerum* Chaud. (14-17 mm), also black but the pits in regular rows, southern tablelands; *L. lacunosum* Macl. (12-15 mm), similar but flushed with bright purple, Coonabarabran district.

Other members of the *Carenum* group include the smooth, all-black *Scaraphites rotundipennis* Dej. (22-37 mm) (Fig. 63), sandy places near the coast, Tasmania, and from Melbourne to Sydney, and *Philoscaphus tuberculatus* Macl. (21-32 mm) (Fig. 64), black, but the elytra roughly sculptured (rugose) and often covered with dirt, mallee and western plains.

Species of *Clivina* burrow in wet mud beside still or running waters; they also fly readily at night and come to light. There are many species differing greatly in size (4-18 mm locally) but otherwise very much alike and difficult to identify. *C. australasiae* Bohe. (9-11 mm) (Fig. 58), shining black with reddish-brown legs, is one of the commonest in our region.

Subfamily BROSCINAE: medium sized to rather large, solidly built, flightless beetles; body pedunculate as in Scaritinae but the fore tibiae seldom modified for digging (weakly dentate in *Gnathoxys*, of the mallee, but this genus barely enters our region). *Promecoderus* is the largest genus, with some 20 species in the southeast; these are mostly metallic bronze in colour but a few are almost black; they are readily recognised to genus by their globular prothorax and oval elytra (Fig. 59) but are hard to identify further (size range in our area: 8-16 mm); most of them occur in light scrub or open grassland but they avoid the desert.

The five known species of *Percosoma* are confined to the wet forests of Tasmania and Victoria (Moore 1960); they may be recognised by their elegant, elongate form and long, pointed mandibles, and *P. sulcipenne* Bates (26-35 mm) (Fig. 65), from western Tasmania, is the finest species. In the related *Eurylychnus* the head is constricted into a pronounced neck: *E. blagravei* Cast. (18-22 mm), Victorian Alps, Snowy Mountains, Brindabellas and coastal ranges of southern N.S.W.; *E. cylindricus* Sl. (18-20 mm), Barrington Tops; *E. regularis* Sl. (21-22 mm), Ebor-Dorrigo district.







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COVER

Illustrated by Stephen Underwood

The Bentwing Swift Moth, *Zelotypia stacyi* Scott (family Hepialidae) is one of Australia's largest moths with species often having a wing span in excess of 230 mm. Adults are tawny brown with silver-white markings and the spectacular raised eye spot gives the fore wing the appearance of a reptilian head. The larvae feed on only a few species of eucalypt including the Sydney blue gum, *E. saligna*, and grow to some 130 mm over a period of 5-6 years. The species occurs in south-eastern Queensland and eastern New South Wales. It is now exceedingly rare in New South Wales.

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NEW TASMANIAN TRECHINI (COLEOPTERA: CARABIDAE)

By B. P. Moore

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Abstract

Tasmanorites laticollis, *Sloanella obscura* and *Tasmanotrechus compactus* spp.n. are described from south-western Tasmania and keys are revised for the genera concerned.

Introduction

The Lower Gordon River Scientific Survey was sponsored by the Tasmanian Hydro-electric Commission and was undertaken in 1976-77 by members of the Zoology Department of the University of Tasmania. Extensive collections were accumulated from numerous stations along 14 selected transects across the valleys of the Gordon, Franklin and Olga Rivers and their tributaries, with the aim of assessing the overall composition of the arthropod fauna.

The resulting material of adult and larval Carabidae and Lucanidae has been studied by the present author and several interesting but undescribed forms have been detected in both families. Some of these novelties are not readily dealt with in the absence of satisfactory reviews of their overall groups, but the following new trechines may readily be attached to a revision of the Australian Trechinae (Moore 1972).

Holotypes of the new species will be deposited in the Australian National Insect Collection, Canberra, and paratypes will be distributed between that depository, the Tasmanian Museum and Art Gallery, Hobart, and the author's collection.

Tasmanorites laticollis sp.n.

(Figs 1, 4)

Types:— *Holotype* ♂, transect 2L.1140 (42°43'S, 145°49'E) (Ridge between Gordon and Olga Rivers, SW Tas.), from moss, 16.ii.1978, L. Hill *et al.* *Paratypes*, 8, both sexes, same collectors, same general locality, various transects and dates, 1976-77.

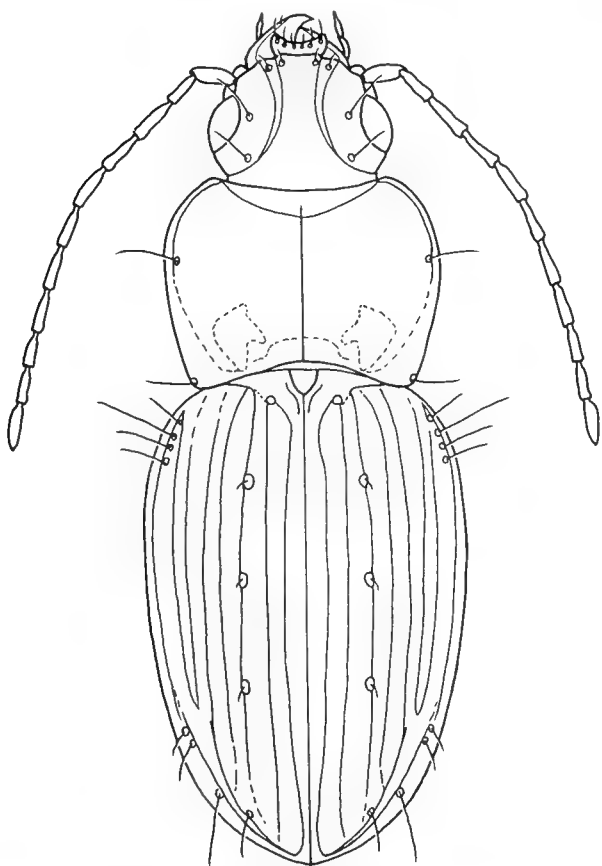
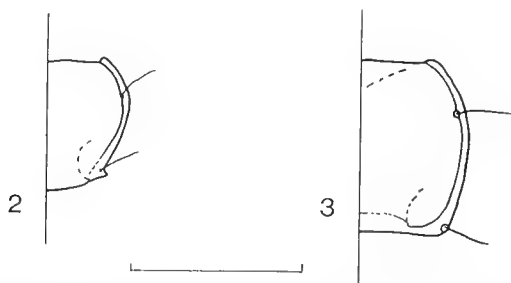


Fig. 1. *Tasmanorites laticollis* sp.n., paratype male. Natural size 5.3 mm long.

Mostly shining black; legs and antennae rufo-piceous; microsculpture very fine, quadrate meshes on head, transverse elsewhere; overall build robust.

Head rather broad, depressed; eyes well developed but not prominent beyond the orbits; orbits short, lightly inflated; frontal furrows deep; mandibles short, broad, acutely pointed; labrum deeply emarginate.

Pronotum strongly transverse (width/length c. 1.45), much wider than head; base and apex emarginate, the former the wider; sides regularly rounded on front two-thirds, then oblique to base; front angles rounded but a little prominent; hind angles lightly rounded, obtuse, reflexed, overlapping humeri; basal impressions broad and deep; marginal channel narrow in front, explanate behind; 2 marginal setae present.



Figs 2-3. Pronota, right side. (2) *Sloanella obscura* sp.n.; (3) *Tasmanotrechus compactus* sp.n. Scale-line = 1 mm.

Elytra broadly oval, rather depressed, about 1.2 x width of pronotum; humeri widely rounded but evident; striae impunctate; first stria strongly impressed, others progressively weaker; third stria carrying three strong discal pores; aedeagus slender (Fig. 4).

Length 4.5-5.3 mm; max. width 1.85-2.2 mm.

This very distinct species may be recognised by its broad pronotum, with rearward projection hind angles; it would run to couplet 10(9) in my key to the genus (Moore 1972), which may be modified as follows:—

- 10(9) Pronotal hind angles acute and out-turned 11
 Pronotal hind angles obtuse, not prominent laterally 10a
 10a Pronotum cordate; side margins sinuate near hind angles; base narrow, rectilinear *austrinus* (Sl.)
 Pronotum subrectangular; side margins not sinuate; base wide, emarginate *laticollis* sp.n.

***Sloanella obscura* sp.n.**

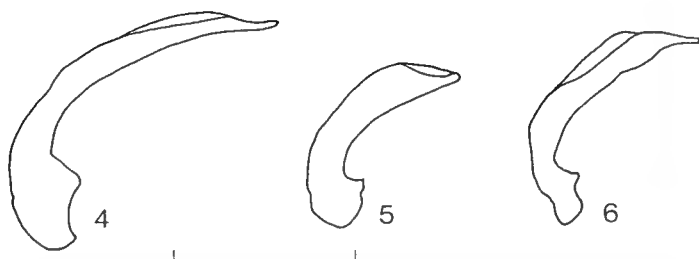
(Figs, 2, 5)

Types:— *Holotype* ♂, Truchanas Huon Pine Reserve, SW Tas. (42°39.5'S, 145°58'E), from moss and litter, 19.iii.1976, C. Howard. *Paratypes*, 15, both sexes, same data as holotype.

Mostly shining piceous; apex of elytra obscurely rufous in mature specimens, more clearly variegated in teneralis; legs, palpi, first (basal) antennal segments and elytral epipleura rufo-testaceous; microsculpture scarcely apparent.

Head rather broad, depressed, across eyes about 0.75 x width of pronotum; eyes well developed, projecting slightly beyond the orbits; frontal furrows deep on disc; mandibles slender but not porrect; labrum deeply emarginate.

Pronotum transverse (width/length c. 1.3), cordate; base sublobate; apex truncate; sides regularly rounded from apex to hind angles; front angles weak.



Figs 4-6. Aedeagal median lobes in left lateral view. (4) *Tasmanorites laticollis*; (5) *Sloanella obscura*; (6) *Tasmanotrechus compactus*. Scale-line = 0.5 mm.

hind angles forming small, sharp denticles; basal impressions broad and shallow; marginal channel narrow in front, wider near hind angles; 2 marginal setae present.

Elytra broadly ovate, c. 1.45 x wider than pronotum; humeri rounded but marked; marginal channel wider beside the humeral pores than elsewhere; striae complete, impunctate; apical striole continuous with the fifth stria; discal pores of third intervals beside third striae; seventh intervals with a single pore at about the mid-point; aedeagus small; median lobe stout, regularly curved, shortly contracted to apex, the latter bluntly pointed in lateral view.

Length 3.3-3.7 mm; max. width 1.35-1.45 mm.

Five additional specimens (not types) are on hand from transect 12 and neighbouring sites, all some 30 km south of the type locality. These specimens differ from the nominotypical form in their weak elytral striae, with those beyond the third being obsolescent. The discal pores are smaller, though similarly located, and the pronotal hind angles are more marked. These specimens may represent a weak subspecies and they require some relaxation of my original generic diagnosis (Moore 1972, p.26), in terms of elytral sculpture.

The four known species of *Sloanella* may be separated by means of the following modified key:—

- 1 Species predominantly dark; elytral 7th intervals with a single pore *obscura* sp.n.
Species predominantly pale; elytral 7th intervals without a pore 2
- 2 Size major (length 5 mm or more) *suavis* Mre
Size minor (length under 4 mm) 3
- 3 Pronotal hind angles tuberculate; posterior marginal seta present *pallida* Mre
Pronotal hind angles rectangular; posterior marginal seta wanting *simsoni* (Sl.)

Tasmanotrechus compactus sp.n.

(Figs 3, 6)

Types:— *Holotype* ♂, transect 7R.1710 (42°51'S, 145°50.5'E) (SW Tas.), 18.ii.1976, C. Howard *et al.* *Paratypes*, 14 both sexes, same collectors, various transects and dates, 1976-77.

Mostly shining black but foreparts somewhat alutaceous; appendages rufous; microsculpture: quadrate meshes on head, transverse elsewhere.

Head subquadrate; eyes well developed but not prominent beyond the orbits; orbits long, lightly inflated; frontal furrows deep; mandibles slender but not porrect finely pointed; labrum deeply emarginate.

Pronotum transverse (width/length *c.* 1.3); base and apex subtruncate, the former the wider; sides regularly curved almost to base, then somewhat oblique but not sinuate; front angles weak; hind angles obtuse, rounded but quite marked; basal impressions vague; marginal channel deep in front, broadly explanate towards base; 2 marginal setae present.

Elytra elongate-oval, *c.* 1.25 x wider than pronotum, rather convex; sides lightly rounded; humeri rounded but marked; striae impunctate, first and second moderately impressed, others progressively weaker, fifth traceable, sixth and seventh obsolescent; anterior discal pore on third interval, against third stria, the posterior (subapical) bridging the interval; aedeagus slender, median lobe regularly curved in lateral view.

Length 3.8-4.5 mm; max. width 1.45-1.7 mm.

This new species may be distinguished by means of the following revised key:—

- 1 Eyes vestigial; cavernicolous species *cockerilli* Mre
Eyes well developed; epigeal species 2
- 2 Pronotum more transverse (width/length *c.* 1.25); elytral outer striae weak or obsolescent 3
Pronotum less transverse (width/length *c.* 1.15); elytral outer striae strong *leai* (Sl.)
- 3 Pronotal side margins slightly sinuate before hind angles; elytra broadly ovate *concolor* Mre
Pronotal side margins not sinuate; elytra less rounded at sides
. *compactus* sp.n.

Acknowledgement

I am indebted to Mr Lionel Hill (University of Tasmania) for the opportunity to study the Carabidae and Lucanidae from the survey.

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NOTES ON THE BIOLOGY AND MORPHOLOGY OF *HESPERILLA SARNIA* ATKINS (LEPIDOPTERA: HESPERIIDAE)

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Abstract

Hesperilla sarnia Atkins is recorded breeding on *Scleria laevis* Retz (Cyperaceae). Egg, larval and pupal descriptions are given, together with comments on adult morphology.

Introduction

Hesperilla sarnia Atkins is a dark brown skipper known from several localities in Queensland between Townsville in the north to Palmwoods in the south (Common and Waterhouse 1981), and collected more recently by the authors on hilltops west of Paluma in northern Queensland. The life history, except for the eggs, has previously been unknown.

Atkins (1978) commented on wing maculation differences between the only two females known at that time, one from southern Queensland and the other from central Queensland. The finding of the immature stages and the rearing and collecting of several males and females from Mt. Stuart, (near Townsville), northern Queensland, as well as the collecting of a further female from Blackdown Tableland, Expedition Range, central Queensland has enabled the description of the life history and has provided additional material for the study of variations in the maculation of adult females.

Life History

FOOD PLANT. *Scleria laevis* Retz, family Cyperaceae.

EGG. Pale yellow, hemispherical, 1 mm high with 22 vertical ribs.

LARVA.

First instar 4-10 mm long, head shining black, body pale green with prothoracic and anal plates pink.

Second to final instar (Figs 1, 2), 14-33 mm long, body pale translucent green in early instars becoming purple in final instar. Prothoracic and anal plates pink brown. A variable area of pink suffusion over segments 6-9 and at the junctions of body segments. Dorsolateral and lateral white lines extending the length of the body but obscured posteriorly by the pink suffusion. Head (Fig. 2) dark brown with cream stripes extending from frons up to occipital margin; frontoclypeus fawn coloured.

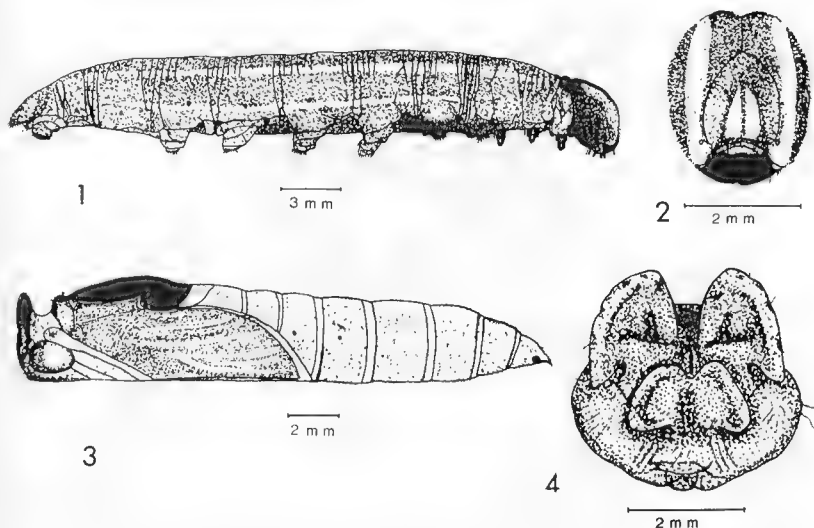
PUPA (Figs 3, 4).

Length 19-23 mm, pale green with darker green thorax and wing cases, and posterior segments densely covered with stiff brown setae. Pupal cap

(Fig. 4) dark brown with an angular projection at the frons and dorsally bearing two crenulate, semicircular projections pointed ventrally.

Notes

On Mt. Stuart, the host plant occurs locally on exposed granite slopes. Larvae and pupae are found in characteristic shelters in plants growing in sheltered situations adjacent to large rocks or under encroaching *Lantana camara* L. bushes. *H. sarnia* occurs together with the closely related *H. malindeva* Lower, and both species are found breeding together, but on different food plants, the larvae of *H. malindeva* being restricted to an unidentified species of *Gahnia* growing in the same situations.



Figs 1-4. Life history of *Hesperilla sarnia* Atkins: (1) mature larva; (2) head of final instar larva; (3) pupa, lateral view; (4) pupal cap.

West of Paluma adult males of *H. sarnia* fly close to the ground on the summits of steep hills together with males of *H. malindeva* and *H. crypsigramma* (Meyrick and Lower).

Adult males from northern Queensland agree closely with the published description of *H. sarnia* (Atkins 1978) and there appears to be little variation in their form. Amongst females, however, there is considerable variation in the arrangement of the hyaline spots on the fore wing. A series of six females from Mt. Stuart appear closest to the female from Palmwoods cited in the type series in that, in addition to the two submedian spots between M_3 and CuA_1 , and CuA_1 and CuA_2 , they have two well defined subapical spots between R_4 and R_5 , and R_5 and M_1 respectively, as well as

a spot above the anal vein. Three of these females each have an additional spot in the cell, and one of them (Fig. 5) has a series of three subapical spots, the additional one lying between R_3 and R_4 .

A female from Blackdown Tableland, Expedition Range, central Queensland is similar to the female from that location cited in the type series, in that the fore wing maculation is reduced to two submedian spots, one between M_3 and CuA_1 and the other between CuA_1 and CuA_2 .

Whether this observed difference between females of the different populations is a constant feature is uncertain and confirmation must await the collection of further specimens from throughout the range of the species.

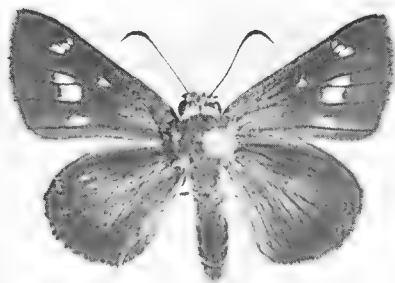


Fig. 5. Adult female from Mt. Stuart Townsville, Queensland.

Identification of females within this group can be difficult and until genitalic studies are performed, the arrangement of the hyaline spots on the fore wing is the most reliable means of identification of the individual species. It is hoped that with this knowledge of the variation within females of *H. sarnia*, specimens from northern areas may be more easily identified.

Acknowledgements

We wish to thank Dr Betsy Jackes for the identification of the food plant, Mr N. Warburton for preparation of line drawings and Mr Richard Parker for preparation of photographs.

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OCCURRENCE OF LEAF-MINING DIPTERA IN CULTIVATED CROPS

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Abstract

Two species of Drosophilidae, *Drosophila busckii* Coquillett and *Scaptomyza australis* Malloch, and one species of Agromyzidae, *Phytomyza syngenesiae* (Hardy) were reared from samples of cultivated crops from the Werribee district, Victoria. A number of parasitic hymenoptera were also reared from the dipterous pupae. These included *Phaenocarpa (Asobara) persimilis* (Papp) (Braconidae: Alysiinae) and two chalcids, *Hemiptarsenus semialbiclava* (Girault) (Eulophidae) and *Trigonogastrella* sp. (Pteromalidae).

Introduction

In August 1980, unusual damage was observed in leaves of lettuce (*Lactuca sativa* L., Compositae) being grown in market gardens at Werribee, near Melbourne, Victoria. The leaves showed evidence of crinkled depressions on the upper surface. Eggs were found inserted under the epidermis, on the under surface of the leaf, beneath the depressions.

The leaves were placed in tubes with their stems in water, covered with a large plastic bag, and incubated at 25°C. After two days leaf-mining was observed, and after one week the first flies were collected and identified as *Drosophila busckii* Coquillett.

In September, further samples of mined leaves were taken from artichoke (*Cynara scolymus* L., Compositae), chicory (*Cichorium intybus* L., Compositae), endive (*Cichorium endivia* L., Compositae) and Cos (*Lactuca sativa* L., Compositae). *D. busckii* and the agromyzid *Phytomyza syngenesiae* (Hardy) emerged from artichoke. The parasitic hymenoptera *Phaenocarpa (Asobara) persimilis* (Papp), *Hemiptarsenus semialbiclava* (Girault) (Eulophidae) and *Trigonogastrella* sp. (Pteromalidae) emerged from pupae of dipterous leaf miners in artichokes. The flies *Scaptomyza australis* Malloch (Drosophilidae) and *P. syngenesiae* as well as the parasites *P. (Asobara) persimilis* and *H. semialbiclava* emerged from endive. *P. syngenesiae* and *P. (Asobara) persimilis* emerged from pupae of unidentified dipterous leaf miners in cos and milkthistle.

In early October further samples of mined leaves were taken from spinach (*Spinacia oleracea* L., Chenopodiaceae); the emerging insects were *S. australis* and *P. (Asobara) persimilis*.

Discussion

D. busckii has not been previously recorded leafmining in plants (Bock pers. comm.), nor has *S. australis* been recorded previously as a leafminer on cultivated Compositae or Chenopodiaceae (Bock pers. comm.). The leaf miner *Scaptomyza flaveola* (Meig.) has been found in cultivated brassicas in Tasmania (Hardy *et al.* 1981), and members of the genus are generally considered to be pests of only Cruciferae in the northern hemisphere (Bock pers. comm., Hering 1951).

P. syngenesiae is widely distributed in temperate zones of both hemispheres and damages many cultivated composites, but damage occurs to

a lesser extent in Australia (Spencer 1973). It is considered to be a native of Europe and was first recorded in Australia from cinerarias in Brisbane (Kleinschmidt 1970). Queensland host records are all confined to the family Compositae (Kleinschmidt 1970) and lettuce is considered one of its most favoured food plants in England (Spencer 1973).

The braconid *P. (Asobara) persimilis* is known to be parasitic on *Drosophila melanogaster* (Meig.) (Papp 1977) but, although it is thought to be a common parasite of *D. melanogaster* in Victoria, it has not been previously recorded as a parasite of dipterous leaf miners (Prince pers. comm.).

The parasites *Hemiptarsenus* sp. and *Trigonogastrella* sp. have been recorded in Australia as parasites of *P. syngenesiae* (Kleinschmidt 1970). *H. semialbiclava* is a widespread species commonly found in Tasmania and south-eastern Australia (Naumann pers. comm.).

The leaf-mining damage was severest in August and early September, particularly in lettuce and artichoke, but declined later in the season, possibly due to parasite activity. There did not appear to be any other suitable breeding sites for the two drosophilid species in the vicinity of the crop and there was no evidence of any prior damage which could have allowed secondary infestation by *D. busckii* and *S. australis*.

Lettuce had leaf-mining damage from as early as the 2-3 leaf stage which in some cases prevented further growth of the plant. Artichokes seemed little affected in terms of yield, despite extensive leaf mines in the lower leaves of the plants.

It is interesting to note that leaf-mining activity by *D. busckii* and *S. australis* has not been recorded previously. Either these species have recently extended their host range or, more likely, previous activity by these two species has not been observed. It remains to be seen whether these two species continue to damage crops of economic importance and whether control measures for dipterous leaf miners in crops in the area may have to be implemented. Some farmers concerned with the extent of the damage attempted chemical control, but without apparent result.

Acknowledgements

I am grateful to Dr I. R. Bock, Department of Genetics, La Trobe University, Bundoora, for identification of *D. busckii* and *S. australis*, Dr D. K. McAlpine, the Australian Museum, for identification of *P. syngenesiae*, Dr I. Naumann, C.S.I.R.O. Division of Entomology, Canberra, for the identification of *H. semialbiclava* and *Trigonogastrella* sp., G. J. Prince for the identification of *P. (Asobara) persimilis* and J. Sutherland who initially collected samples from the field.

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NOTES ON A DEFORMED WORKER OF THE ANT GENUS *IRIDOMYRMEX* (HYMENOPTERA: FORMICIDAE)

By J. D. Majer

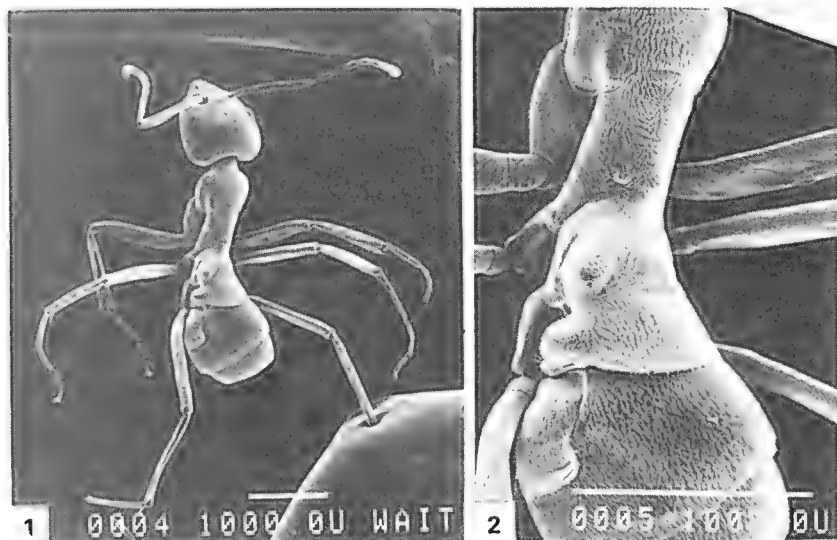
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Abstract

A deformed worker of *Iridomyrmex* sp. 21 (ANIC) is described and the cause of the deformity is postulated.

Workers of *Iridomyrmex* sp. 21 (ANIC), a member of the *agilis* species group, were recently collected by pitfall trap in jarrah (*Eucalyptus marginata*)/marri (*Eucalyptus calophylla*) open-forest at Red Hill, 28 km north-east of Perth G.P.O. One of the specimens was deformed, and two scanning electron micrographs of it are shown in Figs 1 and 2.

Anterior to the mesonotum the specimen is externally normal. However, the propodeum and gaster are fused. This gives the ant an hourglass shape. The petiole is enlarged and situated to the left of the midline. Slightly anterior to this, and adjacent to the propodeal spiracle, is a small conical protuberance, also situated to the left of the midline. A large sclerite is visible on the left hand side of the first gastral segment (abdominal III). This appears to be a sternite which has extended upwards from its normal position.



Figs 1, 2. Scanning electron micrograph of dorsal surface of deformed *Iridomyrmex* sp. 21 (ANIC): (1) general view; (2) close-up of deformed area. The horizontal bars represent 1000 microns.

The cause of this abnormality is not known. Similar deformities are uncommon but not unknown in Australian ants. This could, however, be due to the early mortality or reduced mobility of deformed specimens. The present example was evidently able to forage, since it was caught by pitfall trap.

The ant is distinctly pupoid in shape, indicating that the deformity might have arisen due to events which occurred during the pupal stage. Possibly the pupa was physically damaged in some way leading to abnormal deposition of adult cuticle. This could explain the localised nature of the deformity. Another reason could be the presence of internal parasites such as nematodes which might have interfered with normal body development. There is no direct evidence here of such parasitism. It is further possible that the ant is a gynandromorph (Wheeler 1937). In this case the abnormality would have arisen from a late developmental cleavage, since the deformity is localised. The abnormal area does not resemble male tissue, so the gynandromorph explanation seems unlikely.

The specimen is deposited in the Australian National Insect Collection.

Acknowledgement

I wish to thank Ms E. Van Der Pennen for preparing the scanning electron micrographs and Dr R. W. Taylor.

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TWO MORE FOOD PLANTS FOR *POLYURA PYRRHUS SEMPRONIUS* (F.) (LEPIDOPTERA: NYMPHALIDAE)

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During December 1981 and January 1982 I observed a larva of *Polyura pyrrhus sempronius* (Fabricius) feeding on *Acacia saligna* at Lugarno, Sydney. The larva pupated successfully and emerged in late January. I have also observed *P. p. sempronius* larvae feeding on *Acacia baileyana* and *Acacia spectabilis* in the same area.

On 14th January 1982, a *P. p. sempronius* was observed in Oatley Park, Sydney, ovipositing on *Acacia prominens* (Gosford wattle) but further observations were not possible.

Neither *Acacia prominens* nor *A. saligna* have previously been recorded as food plants of *P. p. sempronius* (Common and Waterhouse, 1981).

Reference

Common, I. F. B. and Waterhouse, D. F., 1981. *Butterflies of Australia*. Second Edition. Angus and Robertson, Sydney. 682 pp.

COLONISATION OF SEEDLING ACACIAS BY ARTHROPODS IN SOUTHERN VICTORIA

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Abstract

Seedling acacias of 21 species were monitored for 18 months of field growth and the arthropods present were collected and counted. 165 species of arthropods were found, the most numerous group being spiders (60 spp.), and many of the phytophagous insects characteristic of mature acacias became established during this period. The data are briefly discussed in relation to the insect communities characteristic of mature acacias in the same area.

Introduction

Many Australian species of *Acacia* Miller support large complexes of insects and other arthropods and, although young trees may be severely defoliated by insects, there is little information available on the development of these consumer communities. This paper presents preliminary information on the initial stages of arthropod colonisation of seedling acacias. A mixed plot of 21 species of *Acacia*, established by planting seedlings in an area of mown meadow on the La Trobe University campus in mid-1976, was used to monitor the arthropods present on the plants during their first year and a half of field growth. Although the plot was established primarily for other purposes, and the different numbers of individuals of the various acacias render comparative data on the communities of different 'hosts' of limited value, the information obtained appears to be the first quantitative assessment of arthropod diversity on young acacias in Australia.

Another leguminous shrub, broom [*Sarothamnus scoparius* (L.) Wimmer], in Britain has a life span comparable with that of some acacias and also supports many insect species (Waloff 1968a). Most of the insects characteristic of broom colonise it within the first two years of growth (Waloff 1968b). Different species of *Acacia* when mature sometimes support markedly different numbers of insect species (New 1979: Coleoptera), and characteristic feeding guilds may be present. Foliage-mining Lepidoptera, for example, do not occur on bipinnate acacias. An aim of the present survey was to determine whether some guilds (necessarily, those not dependent on reproductive structures) develop on young trees, or whether the more characteristic insect complements of particular *Acacia* species appear only in later life.

Study area and methods

The area used, an almost level region on the north of the La Trobe University campus, was mown and cultivated before planting the trees in mid-1976. Seedling acacias, obtained from either the university nursery or the Forests Commission Victoria nursery at Mt. Macedon, were searched individually and any insects were removed. These consumer-free seedlings were planted on a 3 x 3 m grid with a larger space between adjacent subplots, and 169 selected trees were inspected monthly for 18 months. During this

period the plot was not tended other than for clipping grass away from the base of any overgrown tree during the first six months and mowing between rows on two later occasions. Mature acacias of several species (but not of all those represented as seedlings), which were possible sources of phytophagous colonisers, were present within a few hundred metres of the plantation. Both acacias endemic to the area and species introduced from elsewhere in Australia were present in the plot and elsewhere in its vicinity.

On each sampling occasion, two people searched the tree directly for all arthropods, and bushier trees were shaken over a beating tray immediately after such examination. Where possible, insects flying off were noted and most other arthropods were removed and brought to the laboratory for examination; exceptions are Coccoidea, Psyllidae, Membracidae and Formicidae, for which representatives were collected to confirm recognition and numbers assessed as 'few' (10 or less), medium (11-50) or 'many' (>50). Heights of trees were noted on each sampling occasion, together with their general condition.

Results

A number of the acacias suffered considerable damage from defoliation during the sampling period, but others appeared almost unaffected by consumers. When planted, the trees were mostly 40-100 cm tall, but some were smaller. At the end of this survey, the largest trees were well under 2 m in height, and the average height increase over the 18 months period was 45.4 ± 32.2 cm. Many trees were thus submerged in the surrounding grass for parts of the period.

Altogether, some 165 species of arthropods were found, many being of only casual occurrence (Table 1). Other than for Homoptera and Formicidae, many were present in only small numbers and on only some tree species (Table 2). The more abundant groups and feeding guilds are as follows:

(a) Arachnida

Spiders were the most diverse group collected, and about 600 individuals, representing 60 species, were found. They occurred on all species of *Acacia*. Blyth (1973) compared the spider fauna of uncut grassland and of 5-8 m high *A. dealbata* in a site close to the present plot. During a seven month study, he collected 47 species from *A. dealbata* and 76 from grassland, with a Sorenson index of $K = 0.28^*$. Most individuals on *A. dealbata* were web-spinners, whereas in grassland a higher proportion of 'hunters' was captured. As in Blyth's study, Argiopidae were the most diverse family on acacias, and Theridiidae, Salticidae, Thomisidae and Clubionidae were also well-represented.

(b) Predatory insects

These were, in general, relatively scarce. The most abundant was the green mantis *Orthodera ministralis* (F.), of which egg cases were also found.

* This index, the quotient of similarity, is given by $\frac{2j}{a+b}$ where j = number of species found in both habitats (A & B) and a and b are the numbers of species found in habitats A & B.

TABLE 1. Incidence and abundance of arthropods on seedling acacias, La Trobe University, 1976-78.

Species	No. trees	Arthropods		Phytophagous spp specific to <i>Acacia</i>	Number of species of		
		No.*	Species		Araneae	Coleoptera	Lepidoptera
<i>acinacea</i>	5	14	12	3	7	1	1
<i>armata</i>	5	18	11	3	6	—	—
<i>botryocephala</i>	5	13	10	4	5	1	2
<i>buxifolia</i>	5	43	9	5	2	—	3
<i>decurrens</i>	6	41	16	9	1	3	4
<i>floribunda</i>	13	177	31	14	3	7	3
<i>hakeoides</i>	5	24	11	5	3	1	3
<i>mearnsii</i>	12	87	28	13	8	4	4
<i>melanoxyton</i>	25	720	90	25	37	17	12
<i>mitchelli</i>	5	21	11	3	7	2	—
<i>mucronata</i>	5	95	21	10	6	3	4
<i>myrtifolia</i>	5	11	9	3	5	1	—
<i>obliquinervia</i>	5	119	41	15	17	5	8
<i>podalyriifolia</i>	12	103	35	11	13	2	4
<i>pravissima</i>	5	159	27	12	10	3	4
<i>pycnantha</i>	26	615	87	31	30	22	12
<i>retinodes</i>	5	181	37	14	14	6	6
<i>saligna</i>	5	38	14	7	2	—	2
<i>stricta</i>	5	258	16	6	7	—	2
<i>suaveolens</i>	5	28	11	4	3	2	1
<i>verticillata</i>	5	47	29	9	13	2	3

* Total of individuals, excluding Formicidae and Homoptera: Coccoidea, Psylloidea, Membracidae.

TABLE 2. Arthropods collected from seedling acacias, La Trobe University, 1976-78.

Group	Total no. (N)	No. species (S)	No. 'host' species (maximum 21)	N/S
Araneae	572	60	21	9.53
Coleoptera	266	32	17	8.31
Lepidoptera — larvae†	222	16	18	13.88
adults†	33	6	8	5.50
Heteroptera	30	6	9	5.00
Aphidoidea	33	2	8	16.50
Coccoidea		3	15	
Psylloidea		3	10	
Membracidae		2	21	
Hymenoptera — Formicidae		6	19	
others	27	17	9	1.59
Diptera	196	12	15	16.33
Neuroptera	6	2	4	3.00
Dermoptera	3	1	3	3.00
Orthoptera	3	2	3	1.50
Mantodea	35	1	7	35.00
Immature stages† — eggs*	497	12	16	41.42
larvae*	36	5	9	7.20
pupae	50	10	13	5.00

† Overlap between species assessed in totals given in Table 1.

* Egg batches, egg sacs, oothecae each counted as 1.

† Excluding Lepidoptera.

This species is common on larger acacias in Victoria, but is also frequently captured in grassland and on other trees and shrubs. A few adult Neuroptera: Chrysopidae (*Chrysopa edwardsi* Banks, *ramburi* Schneider) were captured, as well as larvae of both these species. Hatched chrysopid eggs were found on several trees but no Hemerobiidae were seen, although two species are common on larger trees nearby.

Single specimens of a syrphid larva and a coccinellid larva were found, as well as adults of *Lemidea subaenea* Mulsant (Cleridae), *Diomous* spp and *Coccinella repanda* Thunberg (Coccinellidae). *Lemidea* may be a regular predator of *Acacia* psyllids (New 1978), *Diomous* are common on larger acacias and *C. repanda* is relatively scarce in the area: only one specimen was found in an extensive survey of *Acacia* Coleoptera in a nearby plot (New 1979). Two species of Hemiptera: Pentatomidae and one of Miridae known to be partially predatory were captured in small numbers.

(c) Phytophagous insects usually associated with *Acacia*

(i) Lepidoptera. The most common larvae found were of three polyphagous moths, *Teia* (= *Orgyia*) *anartoides* (Walker) (Lymantriidae), *Epiphyas postvittana* (Walker) (Tortricidae) and *Diggleisia australasiae* (F.) (Lasiocampidae). Several species of Geometridae more closely associated with *Acacia* were also represented, and several phyllodinous acacias were mined by Gracillariidae or Cosmopterygidae. These attacked the first-formed phyllodes of several individuals of *A. melanoxylon*, *A. pycnantha* and *A. obliquinervia*. Adults found were all of species represented also as larvae, with the single exception of a resting *Pieris rapae* L.

(ii) Homoptera. All species found are believed to be specific to *Acacia*. They include the colonial *Pseudococcus acaciae* (Maskell), three species of Psyllidae and the common membracid *Sextius virescens* (Fairmaire). All occurred in relatively large numbers on many host species and *Pseudococcus* and *Sextius* were usually tended by numerous ants. Psyllidae were found on young flush growth of their hosts.

(iii) Coleoptera. Twenty four species of phytophagous Coleoptera, mainly Chrysomelidae and Belidae, are mostly known only from *Acacia*. The most abundant species was *Monolepta froggatti* Blackburn, and was found on nine host species.

(d) Phytophagous insects not associated with *Acacia*

Some phytophagous species found are clearly not associated with acacias and are probably of purely casual occurrence. They were all scarce, and included several Chrysomelidae usually found on eucalypts, and aphids.

Not all *Acacia* species supported large numbers of arthropods (Table 1), although the most common orders occurred on all host species examined. Total numbers of taxa found on different species ranged from 9 to 90, and only *Sextius virescens* was found on all possible hosts. Although spiders were found on all *Acacia* spp, no species occurred on more than 15 host

species. In general, the most abundant host trees (*pycnantha*, *melanoxylon*) yielded more species and individuals than other trees, and there was considerable variation in the fauna of the 'scarcer' tree species.

Discussion

Many of the characteristic faunal elements of acacias in this area had become well-established by the end of this survey, and there appeared to be no phytophagous taxa solely characteristic of, or limited to, juvenile trees. All species found have been captured also on larger trees. In particular, Homoptera and Lepidoptera were present on a wide range of young trees and have the potential to cause substantial damage. However, the young trees (many of which were 'submerged' in surrounding vegetation for much of the period of this survey) are architecturally considerably less complex than mature trees although, with some exceptions, they furnish an equivalent suite of resources. More complex 'architecture' is associated with greater consumer diversity (Lawton 1978, Southwood *et al.* 1979). On acacias, for example, some feeding guilds (flower galls, seed eaters, many wood borers) are found only on mature or old trees. The early colonisers, however, included a number of relatively specialist taxa which are considerably more host-specific than some of the phytophages found and, for example, the first phyllodes developed on several individual trees were attacked by miners. All, or a large proportion of, the phyllodes of some trees were attacked while still relatively soft, an attack pattern characteristic of many of the *Acacia*-mining Lepidoptera in the area. Psyllidae were also particularly characteristic of flush growth, and were largely absent from fully-expanded phyllodes. The presence of ants attending *Sextius* and other Homoptera indicates that intimate associations between colonising species also develop at an early stage.

In general, however, many of the species found are those also characteristic of older trees, but with some major components of the communities of older trees being considerably less diverse. This applies especially to Lepidoptera and Coleoptera. Many species of these orders found are relatively generalist in that they feed either on a wide range of *Acacia* species or also on other kinds of plants.

There were a few unexpected absences in relation to the known insect fauna of larger trees in the area. Hemerobiidae, for example, were not found, although *Micromus tasmaniae* (Walker) is common on low vegetation in the area and *Drepanacra binocula* (Newman) is particularly characteristic of acacias (New, unpublished). Larvae of the lycaenid butterfly *Jalmenus evagoras* (Donovan) frequently occur on *A. melanoxylon* elsewhere on the campus, but were not found on the seedling trees. Foliage-feeding Chrysomelidae, some of which may occur in enormous numbers on acacias (Elliott 1978: *Pyrgoides orphana* (Erichson) on *A. dealbata* in Tasmania), were largely absent, and none occurred in large numbers.

As Lawton (1978) has emphasised, the seasonal distribution of the insect species associated with a plant is very different from the total number

of species found, and the number of phytophagous species may vary markedly with season. In this survey, phenological differences are largely obscured by the low and sporadic incidence of many species. The more common phytophages have been studied also on larger trees and some have a clear seasonal pattern (New 1979 and unpublished). In general, the incidence on young trees of the more common Homoptera, Coleoptera and Lepidoptera occurred within the predictable 'active periods' on older trees.

Acacias may form dense groups, but even isolated trees can support many arthropod species, and large populations of some of these. Davis (1975) recognised four inter-related factors relevant to the study of such 'host-plant islands', namely size and isolation of the habitat, colonising ability of the animals, and time. In this study, the colonists found have nearly all been found in nearby (to several hundred metres) source populations. Many of the spiders are non-specific to acacias and are widespread in the area. The major limitation to the numbers of species found appears to be time and numbers/'complexity' of plants: the more numerous species of *Acacia*, effectively increasing the 'island size', supported more species of colonisers over the period of this survey.

As many of the inhabitants of acacias of all ages became established on young trees during this survey period, it is implied that many characteristic elements of the insect communities of these trees may persist over much of the life of their host plants.

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I am very grateful to Mrs J. Tenberge, Mrs B. Lee and Mrs P. Pase for their careful assistance in this work.

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BOOK REVIEW

The Pentatomoidea (Hemiptera) of northeastern North America with emphasis on the fauna of Illinois by J.E. McPherson. Published 20th May, 1982. 8vo. 240 pages, illustr. Southern Illinois University Press, P.O. Box 3697, Carbondale, Illinois, 62901. Price US \$30.00

This book provides a comprehensive, systematic treatment of the pentatomid bugs of north-eastern North America. Much of the text (96 pages) includes keys which allow identification to species, and data on the distribution and biology of these species. A map of each species' distribution in Illinois is included and also 102 figures illustrating characters used in the keys. There is a brief introduction of eight pages, eight tables summarising useful data, an extensive list of literature and an index. Some 120 species and subspecies in five families are covered.

There are no illustrations of the species; identification relies on the keys only. This is probably adequate in most instances but should doubt exist there is no ready means of checking a key determination. If figures of the species had been included the work would have been considerably more valuable.

While the book is, of course, of most value to those interested in the American bug fauna, it is nevertheless, of some interest to Australian workers. The keys to families and genera, together with their illustrations are useful. At US\$30 the book is worth purchasing by pentatomid specialists.

M. S. MOULDS

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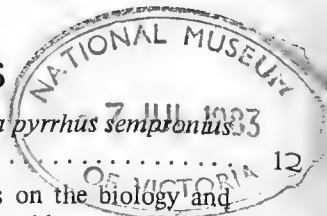
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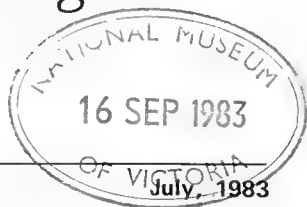
The Bentwing Swift Moth, *Zelotypia stacyi* Scott (family Hepialidae) is one of Australia's largest moths with species often having a wing span in excess of 230 mm. Adults are tawny brown with silver-white markings and the spectacular raised eye spot gives the fore wing the appearance of a reptilian head. The larvae feed on only a few species of eucalypt including the Sydney blue gum, *E. saligna*, and grow to some 130 mm over a period of 5-6 years. The species occurs in south-eastern Queensland and eastern New South Wales. It is now exceedingly rare in New South Wales.

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MIGRATION RECORDS IN AUSTRALIA. 3. DANAINAE AND ACRAEINAE (LEPIDOPTERA: NYMPHALIDAE)

By C. N. Smithers

The Australian Museum, 6-8 College Street, Sydney, Australia, 2000

Abstract

Of the 16 species of Danainae and one species of Acraeinae occurring in Australia nine species are recorded as confirmed or suspected migrants. This note presents a summary of information on their movements.

Introduction

Eight of the 16 species of Danainae occurring in Australia and the single Australian Acraeinae have been observed to migrate or are suspected of doing so on indirect evidence. This is a higher proportion than is found in the Hesperiidæ (one species out of more than a hundred) or the Papilionidæ (two migrant species in eighteen). This paper summarises information on the movements of Danainae and Acraeinae; parts 1 and 2 of this series of papers giving similar summaries for some orders other than Lepidoptera and for the Hesperiidæ and Papilionidæ have already been published (Smithers 1970, 1978).

Danainae

Danaus affinis affinis (F.)

Williams (1930) mentions that this species has migratory habits and Moulds (1964) records two southern specimens at Broken Bay, New South Wales in March 1963. It has been sighted on four occasions moving east or north-east at Mount Tamborine, Queensland (obs. G. Sankowsky) and one specimen was taken at Careel Bay, N.S.W., an area in which it is not usually present, on 5.ii.1973 (obs. M. S. Moulds). Although details are few the above observations suggest at least occasional population movement.

Danaus chrysippus petilia (Stoll)

Williams (1930) mentions this species as a migrant and reported (Williams 1933) that a southerly movement took place in about 1915. Alexander (1917) reported a large flight in south-western Australia in the summer of 1914-15 and that the species visits the area each year. It is certainly a species given to making sudden appearances in areas from which it is usually absent and it seems to be very unevenly distributed through its range. Holloway (1962) reported its appearance in New Zealand and it was breeding there in April - May 1958 (Wise 1958). A strong easterly movement was reported 6th April 1973, at Kyneton, Victoria (Anonymous 1973). From these few published records, and the more recent observations given in Table 1, it is clear that mainly northerly movements can be expected in April.

TABLE 1
Summary of new migration records for *Danaus chrysippus petilia*

Locality	Date	Direction	Observer
Sawtell, N.S.W.	4-7.iv.1967	mainly N	P. Wilson
48km N of Singleton, N.S.W.	12.iv.1977	N 10/min/20m	C. N. Smithers
48km N of Singleton, N.S.W.	16-17.iv.1977	N 1/min/20m	C. N. Smithers
48km N of Singleton, N.S.W.	23-25.iv.1977	N 1/5 min/20m	C. N. Smithers
48km N of Singleton, N.S.W.	15.iii.1980	N 1-2/hr/20m	C. N. Smithers
48km N of Singleton, N.S.W.	22.iii.1980	NW 1/15 min/20m	C. N. Smithers
48km N of Singleton, N.S.W.	12.iv.1980	NW 3/5 min/20m	C. N. Smithers
48km N of Singleton, N.S.W.	21-22.iii.1981	N 3/min/20m	C. N. Smithers
48km N of Singleton, N.S.W.	28-29.iii.1981	N 10/min/20m	C. N. Smithers
48km N of Singleton, N.S.W.	5.iv.1981	N 2/min/20m	C. N. Smithers

Danaus hamatus hamatus (W. S. Macleay)

The literature from King (1826) to Straatman (1963) contains many references to appearance and "clustering" of this species at specific sites and there are several more recent records e.g. Townsville 1968-69 and Coen, Queensland, June 1971 (obs. G. B. Monteith); Cabbage Tree Island, New South Wales, December 1969 (obs. A. D'Ombrian); Mission Beach, Queensland, April 1971 (obs. M. S. Moulds); Magnetic Island, Queensland, April 1973 (A. Young). There are, however, no early records of directions of

flights. Wise (1965) mentions its appearance in New Zealand. Moulds (1963, 1964) and Peters (1963b) list specimens seen in and near Sydney (well to the south of its usual range); all sightings were in January, February or March. Straatman (1963) recorded a strong NNW migration between Tully and Ingham, Queensland, with numbers reaching a peak (55-65/min/80 m) in mid April.

Table 2 gives a summary of recent significant flight records.

The flights observed in December 1969 were in various directions suggesting somewhat local movements but from late February to May 1970 the flights indicate predominantly southerly movements over a wide area. Records for December 1970 and early January 1971 again suggest haphazard movement but from about mid January there is again an indication of southerly movement which penetrated further south than Sydney and was still evident as a movement even from the small numbers reaching Sydney. The onset of the southerly movement was apparently a little earlier in 1971 than in 1970. Although less detailed than that for later years the data provided by Moulds (1963, 1964) and Peters (1963b) suggest that similar unusually strong, southerly extensions took place in 1962 and 1963, perhaps on a smaller scale.

In general terms it seems that early local flights of various directions in the northern areas become predominantly southerly as the season progresses but the time at which this happens varies from year to year i.e. anything from January (as recorded by Moulds *loc. cit*) to as late as February (e.g. as in 1970).

Danaus plexippus (L.)

The regular, large-scale flights of this species in North America are amongst the frequently cited classic cases of insect migration. Such spectacular movements have not been seen in Australia but widespread, regular, population movements of a less conspicuous nature do occur. These have already been described and discussed (Smithers 1977) and details need not be repeated here. The annual cycle includes winter periods when part of the population is in reproductive "diapause" and during which clustering takes place at certain sites.

Euploea core corinna (W. S. Macleay)

There are very few published records of obvious population movements in this species but several authors have reported its concentration over small areas (e.g. Poulton 1922); this suggests movement into and away from certain sites. It has also been recorded in numbers well beyond its usual breeding range in some years. In 1948 there was a spread, with specimens reaching Victoria (Anonymous 1948; Plant 1948; Chadwick 1951, 1954). For April and May 1955 Straatman (1963) recorded a flight between Tully

TABLE 2
Summary of new migration records for *Danaus hamatus hamatus*

Locality	Date	Direction	Observer
Wallville, Q.	xii.1969	N	G. Sankowsky
Gladstone to Rockhampton, Q.	xii.1969	E	G. Sankowsky
N of Rockhampton to Sarina, Q.	xii.1969	W	G. Sankowsky
Brisbane, Q.	xii.1969	W	G. Sankowsky
Mackay, Q.	28.ii-3.iii.1970	SE 29/5min/30m	A. Bird
Mackay, Q.	7.iii.1970	SW	A. Bird
Sawtell, N.S.W.	17.iv.1970	large numbers	P. J. Wilson
Eurimbulah, N of Bundaberg, Q.	v.1970	SE	G. Sankowsky
Cairns, Q.	v.1970	S large numbers	G. Sankowsky
16km offshore in Whitsunday Passage, Q.	vi.1970	on ship	A. Bird
Brisbane, Q.	14.xii.1970	S 96/hr	P. Bensley
Inverell, N.S.W.	1.i.1971	W	M. S. Moulds
Brisbane, Q. to Yerongpilly, N.S.W.	9-20.i.1971	SE	A. Bird
Urunga, N.S.W.	20-27.i.1971	SSW several dozen/day	M. S. Moulds
Willoughby, N.S.W.	26-28.i.1971	S several sightings	P. Wilson
Maitland, N.S.W.	1.ii.1971	large numbers	A. D'Ombrian
Conobolas, N.S.W.	ii.1971	large numbers	J. Hicks
Sydney (several localities)	1-2.ii.1971	S large numbers	L. C. Haines, J. V. Peters, C. Trickett, G. A. Holloway & C. N. Smithers
Gloucester, N.S.W.	6.ii.1971	SE	A. B. Rose
Booral, N.S.W.	7.ii.1971	SW, W	A. B. Rose
Camden, N.S.W.	8.ii.1971	several	C. Trickett
Sydney (several localities)	13-15.ii.1971	S, SSE	J. V. Peters, A. B. Rose, C. N. Smithers
Sydney (several localities)	20-21.ii.1971	S, SSE	M. Lovell, J. V. Peters, A. B. Rose
Sydney (Turramurra)	28.ii.1971	1 specimen	C. N. Smithers
Mackay, Q.	viii.1971	SE	A. Bird
Conway National Park, N.S.W.	23.iii.1972	ENE 1/min/40m	P. Wilson
Ravenshoe, Q.	vi.1973	E	M. Lockyer
Yeppoon, Q.	14.ii.1974	NNE 6/min	A. Atkins

and Ingham, Queensland. Moulds (1963) records a few specimens from in or near Sydney, New South Wales, in January 1962. Records from 28th October to 6th June 1963 (Moulds 1964, Chadwick 1974a) indicate a major invasion to the south with breeding through at least one generation well south of its usual breeding areas. Fletcher (1973) records an invasion of Heron Island, Queensland, and a south-easterly flight in January 1971. The latter coincided with sightings at Maitland, New South Wales (obs. A. D'Ombrain). From December 1973 to April 1974 there are records for Sydney (Nikitin 1974), Wollongong (Chadwick 1974b) and several inland areas of New South Wales (Anonymous 1974a) which suggest another southerly invasion. One Sydney record is as late as June 1974 (Anonymous 1974b). Sightings in Victoria were reported from several localities between January and April 1974 (Quick 1974). Table 3 includes records of sightings in the Sydney area during October and November 1973 and in May 1977.

TABLE 3
Summary of additional sightings of *E. core corinna* which suggest migration

Locality	Date	Direction	Observer
Lorn (Maitland), N.S.W.	14.ii.1971	specimens seen	A. D'Ombrain
Magnetic Island, Q.	iv.1973	concentration	A. Young
Sydney, N.S.W.	21.x.1973	specimen taken	H. G. Smithers
Sydney, N.S.W.	21.x.1973	specimen seen	D. K. McAlpine
Sydney, N.S.W.	1.xi.1973	specimen seen	C. N. Smithers
Sydney, N.S.W.	xi.1973	many sightings	A. B. Rose
Sydney (Avalon Beach), N.S.W.	25.i.1974	2 specimens taken	M. S. Moulds
Sydney, N.S.W.	6.v.1977	specimen seen	G. Daniels
Sydney, N.S.W.	iii-iv.1981	several seen	R. Brewer

Clearly, *E. core corinna* is a species in which movements take place within the usual breeding range with fairly frequent extensions of the range southwards, probably most noticeable when populations are high. Moulds (pers. comm.) reports that continuous breeding takes place at Umina and Avoca Beach (near Gosford), with larvae present in large numbers in March.

Euploea sylvester sylvester (F.)

Clusters of this species have been reported from Townsville and Coen, Queensland, in June 1971 (obs. G. B. Monteith) and from near Darwin, Northern Territory, in August 1970 (obs. J. V. Peters) while clusters of several thousands were seen in rainforest along Peach Creek, 25 km NNE of Coen between 2nd and 4th November 1979 (obs. M. S. Moulds). The clustering habit suggests population movement as this is part of the behaviour cycle of several migrant species. Obvious unidirectional flights have, however, not yet been reported.

Euploea eichorni Staud.

Straatman (1963) records a NNW migration from mid February to mid April 1962 between Tully and Ingham, Queensland, and clustering at Forest Beach, Queensland, in late June 1961. These observations suggest behaviour similar to that of *E. sylvester*.

Euploea tulliolus tulliolus (F.)

Evidence of migration in this species comes from three observed flights, one N at Mackay, Queensland, in May 1969, with a density of 3.4/10 /mins (obs. A. Bird), one N, 140 km N of Bundaburg, Queensland, in May 1970 in which very large numbers were seen (obs. G. Sankowsky) and one S at North Beach, near Urunga, 23rd January 1971 (obs. M. S. Moulds).

Acraeinae

Acraea andromacha (F.)

Williams (1930) records a flight of this species through Cairns, Queensland, in May and June 1928 and this appears to be the only record of a population movement sighting. Moulds (1963, 1964) and Peters (1963a, 1963b) record specimens from in and near Sydney, New South Wales, during the summers of 1962 and 1963. An additional record is a sighting at Bulli, New South Wales, on 13th April 1970 (obs. J. V. Peters). The sporadic southerly sightings are probably due to invasion during a temporary southerly extension of range, as in *E. core*.

Comments

Observations so far made indicate that the migratory habit is more frequent in the nymphalid subfamily Danainae than in the Hesperiidae or Papilionidae. In Australia the Danainae are predominantly species of the "Torresian" zoogeographic province and, as such, have their main centres of distribution and breeding in the northern and north-eastern parts of the continent. Variations in climate probably provide opportunity for them to extend their range southwards from time to time and some of them, e.g. *E. core*, can breed through one or two generations in the area of southerly extension. Clearly, however, permanent establishment is difficult. It is interesting to note that the widespread *Danaus plexippus* exhibits differences in behaviour and seasonal cycles in the northern "Torresian" province from those which it exhibits in the more southerly "Bassian" zoogeographic province (Smithers 1977).

To date there has been little detailed work on Danaine population movements within the main areas of their distribution and breeding; comparative studies on the species of *Euploea* and *Danaus* would probably yield interesting data as they undoubtedly have regular, if limited, population movements.

Acknowledgements

I would like to thank the many observers mentioned in this note for providing records of migration and M. S. Upton and M. S. Moulds for providing references to migration in Australia.

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THE TYPE HOST OF *APONOMMA HYDROSAURI* (DENNY) (ACARI: IXODIDAE)

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Abstract

The type host of *Ixodes hydrosauri* Denny, 1843 is *Tiliqua nigrolutea* not *Varanus gouldii*.

In the absence of Denny's type material (presumed lost), Roberts (1964a) synonymised the reptile ticks *Aponomma hydrosauri* (Denny 1843) and *Aponomma trachysauri* (Lucas 1861). This action was based on the parasitism of reptiles by both species and has since been universally accepted.

One apparently previously unnoted fact supports Roberts' action. Denny's types were taken by John Gould from "one of the large lizards of Van Diemens Land [=Tasmania], known to the colonists by the general name of the Guana". Denny supposed this to be the sand goanna, *Varanus gouldii* (then *Hydrosaurus gouldii*) and hence proposed the name *Ixodes hydrosauri*. However, no varanid occurs in Tasmania (Hewer and Mollison 1973). The largest lizard occurring naturally in Tasmania is the blotched blue-tongue skink, *Tiliqua nigrolutea*. Records of *T. scincoides* from Tasmania are in error (Hewer and Mollison 1973) and *T. rugosa* was introduced to Tasmania (Lord and Scott 1924), presumably well after 1843. *T. nigrolutea* is commonly known in Tasmania as the Goanna (Lord and Scott 1924; Hewer 1948; Hewer and Mollison 1973) and is undoubtedly the host from which Gould collected Denny's types. Only one species of *Aponomma* was recorded from Tasmanian reptiles by Roberts (1964b), and *T. nigrolutea* was found to be its most common host in Tasmania (Roberts 1964a, b). The name *Aponomma hydrosauri* therefore almost certainly belongs to this species.

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THE EGG AND FIRST INSTAR LARVA OF *ITALOCHRYSA INSIGNIS* (NEUROPTERA, CHRYSOPIDAE)

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Abstract

The egg, oviraptor and first instar larva of *Italochrysa insignis* (Walker) are described and figured.

Introduction

The widely-distributed chrysopid genus *Italochrysa* Principi is represented in Australia by nine described species (New, 1980). Many of these are very limited in distribution, and only *I. insignis* (Walker) is widely distributed in southern Australia. Although it is quite common, no biological information has been published on this species. The only available data on the early stages of any member of the genus refer to the European *I. italica* (Rossi) (Principi 1943, 1946).

The following notes on the egg and first instar larva of *I. insignis* are made from the preserved offspring of a female captured in Victoria. Measurements are given in millimetres, and drawings are from slide-mounted material.

Italochrysa insignis (Walker) (Figs 1-10)

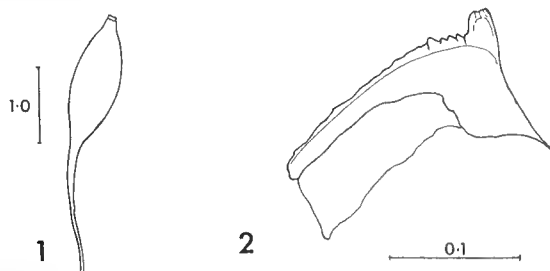
For the full synonymy of this species see New (1980: 20).

EGG (Fig. 1)

Slender, tapered, ovoid with prominent micropyle; very fine areolate sculpturing visible only at high magnification; laid on a single stalk. Very pale grey when laid, micropyle white; darkens to brownish grey towards hatching. Length ($n = 5$) 1.56 ± 0.03 , greatest breadth 0.63 ± 0.02 ; stalk length 8.3 ± 0.3 .

OVIRUPTOR (Fig. 2)

Lightly sclerotised; prominent anterior process, posterior elongate blade with incipient teeth.



Figs 1, 2. *Italochrysa insignis* (Walker): (1) egg; (2) oviraptor, lateral aspect. (Scales in mm).

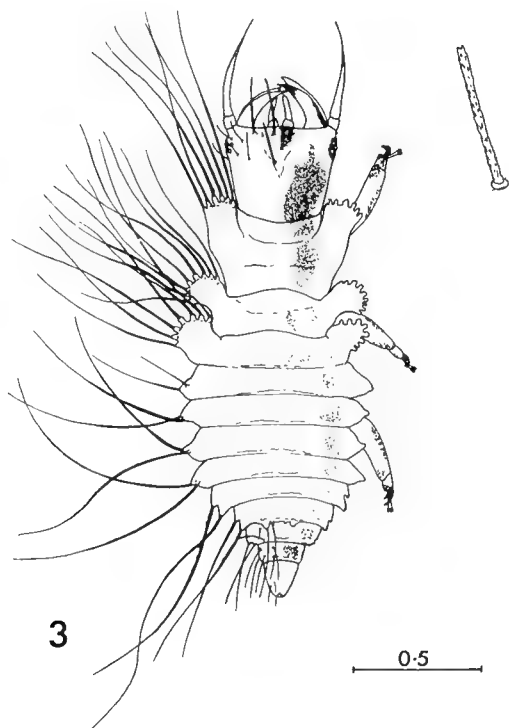
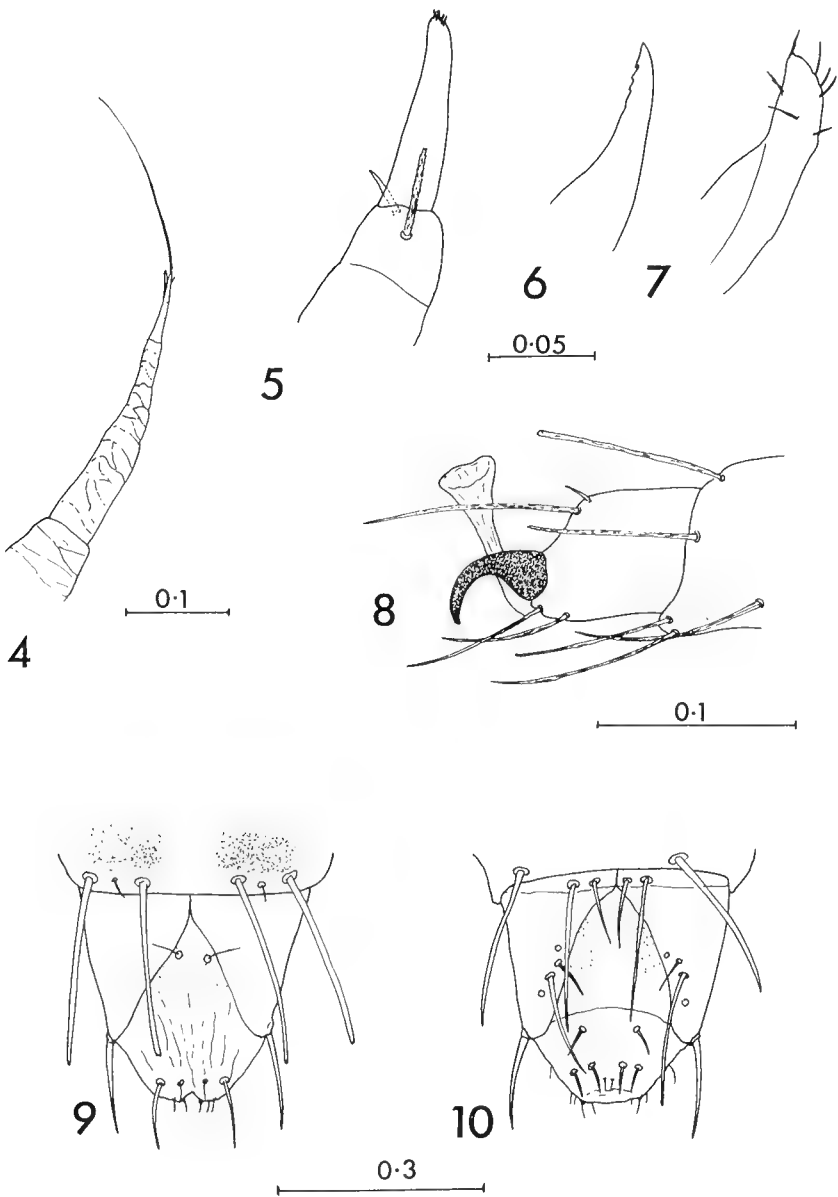


Fig. 3. *Italo-chrysa insignis* (Walker): first instar larva, dorsal aspect, with insert of single cranial seta to indicate ornamentation. (setae omitted from right side; legs and pigmentation omitted from left side, scale in mm).

FIRST INSTAR (Figs 3-10)

Body length (labral margin to end of abdomen, $n = 4$) 1.9 ± 0.1 ; greatest head width 0.45. Pale grey with dark brown markings as indicated in Fig. 3. Posture strongly 'hunched', with short head partly retracted into prothorax. Head appendages short; palpi rounded apically and with small group of apical sensilla, preapical segment with two setae (Fig. 5); palpi convergent medially; mandibles and maxillae *ca.* 1.5 times palp length, basally stout; mandible with two setae on outer edge near base, apex (Fig. 6) slightly serrate; maxilla apex (Fig. 7) bluntly rounded, with about six short setae. Antenna (Fig. 4) strongly tapered, with long apical seta and short seta near base of this; *ca.* 1.6 times mandible length; flagellum with irregular reticulate sculpturing. Dorsal labral margin of head with four long blunt ornamented setae, a minute seta between each lateral pair; a long seta on vertex behind each inner labral seta, and two smaller setae to each side of these; two small setae in front of each eye; one marginal seta behind each eye. Eyes with five stemmata in black surround.



Figs 4-10. *Italochrysa insignis* (Walker), first instar larva: (4) antenna; (5) apex of palp; (6) apex of mandible; (7) apex of maxilla; (8) tarsal region; (9) abdominal apex, dorsal aspect; (10) abdominal apex, ventral aspect. (Scales in mm).

Thoracic segments each with pronounced dorsally-reflexed lateral lobes, each lobe bearing 6-8 long setae each arising from separate basal tubercle. Abdominal segments I-VI each with small tapered lateral lobe bearing two long setae: setae on segment I shorter than on segments II-VI. Thorax and abdomen segments I-VI without other conspicuous setae but with dense dorsal coating of very fine hooked hairs (not shown in Fig. 3). Abdomen beyond segment VI narrow and with relatively short setae; apex as in Figs 9, 10. Legs with slightly ornamented tae, claw (Fig. 8) short and strongly curved; empodium long.

MATERIAL EXAMINED

Victoria, Hurstbridge, ex ♀ at light, 9.i.1982; 8 eggs laid, hatched after 8 days under uncontrolled conditions.

Comments

The larvae were provided with a range of small insects, including immature Psyllidae from *Eucalyptus* and *Acacia*, but refused all food. All died within a week. They remained motionless on the egg shells for several hours after hatching but were thereafter active, and ran when disturbed. They became covered with small particles of debris within about two days.

The egg is closely similar to that of *I. italica*, and is considerably more slender than eggs of many other Chrysopidae. The larva also strikingly resembles that of *I. italica* (third instar figured by Principi, 1946) in its hunched form, prominent thoracic lobes, dense dorsal vestiture, and form of cranial setae and appendages, and thus serves to augment knowledge of a suite of characters which may eventually be considered diagnostic for the genus. Perhaps more notably, pending information on other species of *Italo-chrysa*, it is probably that the close resemblance between larvae of the two species, together with the refusal of insect food by the present larvae, reflects a similar feeding habit. *I. italica* is unusual in the Chrysopidae, as it lives in the nests of *Crematogaster* ants. Some Australian species of *Crematogaster* nest in twigs (Brown and Taylor, 1970), but I am not aware of any records of Chrysopid larvae from ant nests in Australia. No larvae similar to those of *I. insignis* have been captured in numerous beating samples from vegetation over several years in Victoria, and further work is needed to clarify their possible association with ants.

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A REVISED KEY TO THE SPECIES OF *PSILOPSOCUS* ENDERLEIN
(PSOCOPTERA: PSILOPSOCIDAE) WITH NEW RECORDS OF
PS. MIMULUS SMITHERS, A PROBABLY PHRAGOMOTIC SPECIES

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Abstract

A revised key to the species of *Psilopsocus* Enderlein is provided. New records for the uncommon, probably phragmotoc, Australian *Ps. mimulus* Sm. are given, extending its known range from The Crater, near Ravenshoe, Queensland, to the Shoalhaven River, New South Wales.

Introduction

Psilopsocus Enderlein includes six described species. Only one, *Psilopsocus mimulus* Smithers, has been recorded from Australia. Three are known from New Guinea, one from Manus Island, one from the Philippines and there is one additional undescribed species, known only from nymphal material, in South Africa.

Members of this genus are particularly interesting on account of the remarkable modification of the abdomen of the nymphs (Smithers 1963, fig. 9). The fifth segment onwards is somewhat swollen and has the apex very heavily sclerotized and truncate. The paraprocts and epiproct are in the form of simple plates which fit closely together, edge to edge, so covering the anus; this gives the end of the abdomen an appearance similar to that of a bostrychid beetle.

Adult psilopsocids are mostly relatively large (up to 5 mm wing length) with dark wings which have more or less complex patterns in various shades of brown. In the field they resemble members of the Myopsocidae but these can usually be distinguished by the pattern being made up of large numbers of small, irregular confluent spots and patches; in the psilopsocids the pattern is made up of fairly extensive irregular patches, most of which are not very clearly delineated.

Nothing is known of the life history of these insects but they usually occur on trees of which the bark shows evidence of wood borer activity. It seems likely that the modified apex of the abdomen of the nymph is an adaptation to living in and sealing wood borer tunnels. If this is so it is the only case of such phragmosis so far known in the Psocoptera.

Mockford (1961) pointed out the close relationship between *Psilopsocus* and the predominantly bark-dwelling Myopsocidae.

Ps. mimulus is not a common species. It was described from one very restricted locality at Lindfield, New South Wales. Repeated attempts to obtain more material from the same area have been unsuccessful. A few additional specimens have, however, been collected over the past fifteen years at other localities. The known range now extends from The Crater,

near Ravenshoe, Queensland, in the north to the Shoalhaven River, New South Wales, in the south.

NEW RECORDS. QUEENSLAND: 1 ♀, Woombye, near Nambour, 11-16.x.1965, D. H. Colless; 1 ♂, The Crater, Mt. Hypipamee, 21.xii.1972, C. N. Smithers and J. V. Peters. NEW SOUTH WALES: 1 nymph, Comerong Is., Shoalhaven River, 27.v.1976, G. A. Holloway; 2 ♂, 1 ♀, 3 nymphs, Couranga Track, Royal National Park, 10.xi.1976, G. A. Holloway; 1 nymph, Whipoorie, near Grafton, 16.v.1978, C. N. Smithers.

Smithers and Thornton (1973) gave a key to the species of *Psilopsocus* but the new material now available exhibits a variation in wing pattern which renders that key unreliable. A replacement key, revised to take account of this variation and including *Ps. manus* Smithers and Thornton, described since publication of the earlier key, is presented here.

Key to species of *Psilopsocus*

1. Median cells of fore wing uniformly coloured (Philippines) *nebulosus*
- Median cells of fore wing not uniformly coloured, with at least a submarginal pale spot 2
2. Ratio wing length: width greater than 3: 1 (Australia) *mimulus*
- Ratio wing length: width clearly less than 3: 1 3
3. Cell R_1 in distal half pale with a poorly defined, darker, elongate median mark 4
- Cell R_1 in distal half brown with a clearly defined pale or hyaline spot at or near wing margin 5
4. Fore wing 2.5-3.0 mm (Manus Is.) *manus*
- Fore wing 4.5-5.0 mm (New Guinea) *pulchripennis*
5. Cell M_2 dark with a pale area adjacent to wing margin only (New Guinea) *nigricornis*
- Cell M_2 dark with a pale spot adjacent to vein M_{1+2} in addition to pale area near wing margin (New Guinea) *marmoratus*

Acknowledgements

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NOTES ON THE LIFE HISTORY OF *BINDAHARA PHOCIDES YURGAMA* COUCHMAN (LEPIDOPTERA: LYCAENIDAE)

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Abstract

The egg, last instar larva and pupa of *Bindahara phocides yurgama* Couchman are described and notes on the life history provided.

Introduction

The Australian Plane, *Bindahara phocides yurgama* Couchman (1965), occurs in northern Queensland, from the islands of Torres Strait south to Townsville (Common and Waterhouse, 1981). It is associated with rainforest habitats, ranging from montane areas such as Kuranda to coastal areas such as Cape Tribulation and Clump Point.

The early stages of the Australian subspecies have not been described although Manski (1960) recorded larvae feeding on the seeds within the berries of *Salacia chinensis* L. (Hippocrateaceae). *Salacia* is common along the beach front at Cape Tribulation, about 100 km north of Cairns, and both eggs and larvae of *Bindahara* have been collected there from it on numerous occasions. The information below is the result of those collections.

Life History

EGG (Fig. 1)

White; flatter than hemispherical, micropylar area slightly depressed; surface with a fine reticulated pattern of pits and intervening ridges. Diameter 0.8 mm, height 0.6 mm.

MID INSTAR LARVA

Similar to last instar.

LAST INSTAR LARVA (Fig. 2)

Head pale brown, thoracic and abdominal segments mottled: segment 1 yellow, with pale central depression, posterior margin black; segment 2 yellow, black around dorsal tubercles and centre strip; segments 3, 4, 5 very pale pink, dorsal and lateral tubercles brown to black, sides of segment 8 very pale pink; segment 9 very pale pink, dorsal and lateral tubercles brown to black; segment 10 very pale pink, edges slightly darker. Slight blue coloration around black markings on all segments. Ventral surface pale yellow, prolegs darker yellow. Segments 2-9 with pairs of low dorsal and lateral tubercles, segments 2 and 3 with a third pair between, others with a wrinkled pitted appearance between. Dorsal tubercles of segments 3-8 each with a pair of long, black stout setae, other tubercles with a group of 2-6

similar setae. Front half of segment 1 with similar setae over entire surface, and segment 10 with similar but paler setae fringing margin. Rest of surface with short, black setae scattered irregularly over surface. Medial dorsal organ and dorsolateral organs not developed. Anal segment enlarged, flattened. Length 16 mm, width 4 mm.

PUPA (Figs 5, 6)

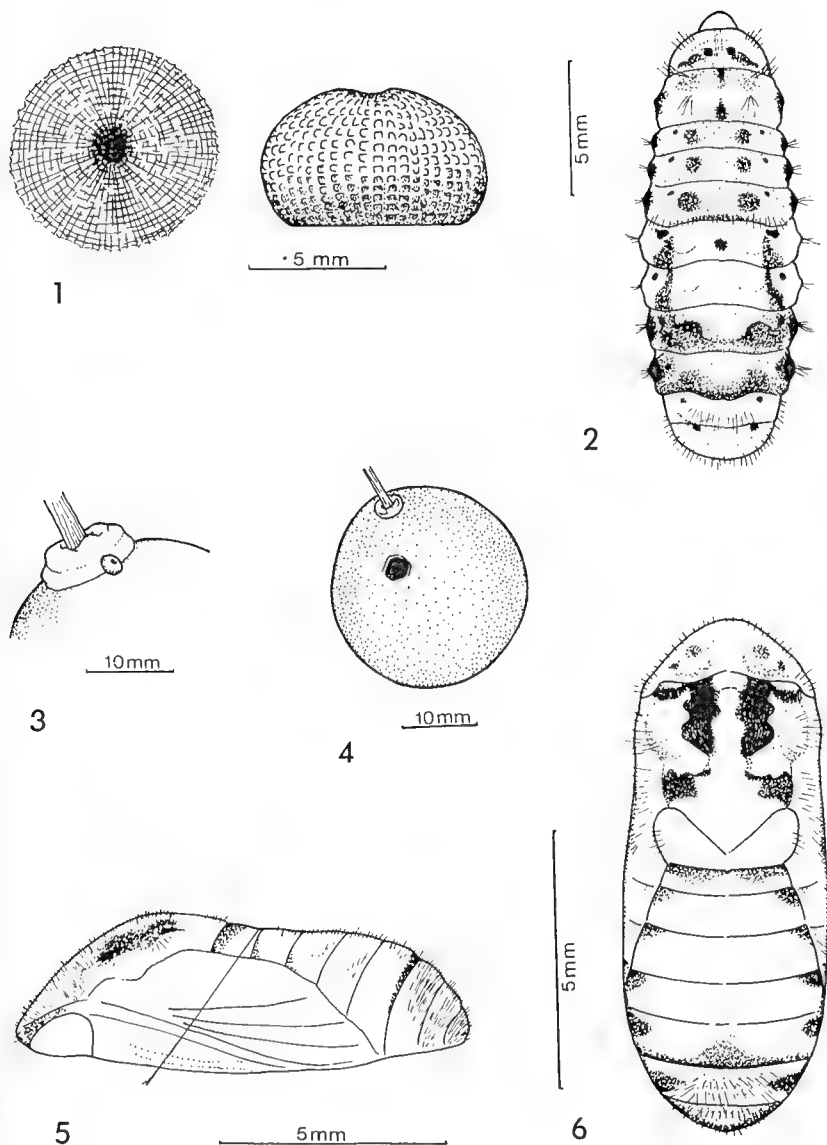
Pale brown, dorsal parts of thorax tending towards pinkish white with dark brown speckling, pair of brownish black spots on middle part of thorax. Pair of dorsal elongate tubercles of thorax, surface roughened. Dorsal surfaces of thorax and abdomen covered with pale erect hairs. Fastened by anal hooks and central girdle to silken pad. Length 10 mm, width 4 mm.

NOTES

Eggs are laid singly on the fruit usually at the base where it joins the stem (Fig. 3) or occasionally on other parts of the fruit, especially on skin blemishes. Up to three eggs have been observed on each fruit but subsequently only one larva was found in each fruit. The first instar larva mines directly through the rind into the seed and feeds internally, ejecting its faecal pellets through a hole in the rind. As in other related genera (*Deudorix*, *Virachola*) the larva plugs this hole with its toughened anal plate when not feeding (Fig. 4). The larva feeds on the seed of the fruit, leaving the flesh and rind intact, only vacating the fruit when development is complete. More than one fruit may be required in its lifetime. Mid-instar larvae which left the fruit and showed no interest in feeding in subsequent fruit, were invariably parasitized by a braconid wasp (*Apanteles* sp.).

Pupae were not found in the field and the preferred pupation site is thus not known. In the laboratory, full grown larvae always left the fruit, and no fruit were ever collected with pupae inside, so in contrast to *Virachola*, *Bindahara* would seem to pupate outside the fruit. Woodhouse (1949) records that the Shri Lankan subspecies leaves the fruit and probably burrows into bark, as individuals would not pupate unless provided with cork in which to burrow. This was not the case here as the larvae made no attempt to burrow in cork provided. When offered containers of restricted size pupation took place on the sides of the containers. When kept in larger containers, mortality of fully developed larvae occurred from what would seem an inability to find a suitable pupation site; this mortality was reduced by providing pieces of dried bark or old dried fruit rinds in which to pupate. Pupal duration was 10-17 days.

The food plant, *Salacia chinensis* L. is a vigorous woody scrambler growing as a low shrub, liana or rarely a small tree (Jones and Gray, 1977). It is widely distributed through India, South-east Asia, and into far northern Queensland (Ding Hou, 1964). In Australia it is found only in coastal areas along sandy foreshores and possibly sandy river banks. The related *S. disepala* (C. T. White) occurs in rainforests away from the coast and at higher



Figs 1-6. *Bindahara phocides yurgama* Couchman: (1) egg; (2) final instar larva; (3) *Salacia* berry with egg *in situ*; (4) *Salacia* berry with hole in rind; (5) lateral view of pupa; (6) dorsal view of pupa.

elevations (Clarkson, pers. comm.) and is possibly the host of *Bindahara* in such areas. The ripe fruit is ovoid in shape, bright orange to red, 2-3.5 cm in length. Each fruit contains a pair of large, hard seeds, surrounded by a thin layer of opaque white pulp (which is edible) then finally the soft red rind. Peak fruiting periods at Cape Tribulation were August and December, though some mature fruit were found at all times when visits were made, allowing continuous breeding of *Bindahara*. Immatures were collected in June through to December. Adults were taken in June, August, September and November, flying around the food plant or feeding on nearby blossom.

Acknowledgements

K. H. Halfpapp and I. C. Cunningham (Mareeba) helped with the collection of fruit. J. Clarkson (Mareeba) provided useful information on the distribution of *Salacia*. Mrs S. Sands (Indooroopilly) made the line drawing of the fruit and immature stages.

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RHYOTHEMIS GRAPHIPTERA (RAMBUR) (ODONATA: LIBELLULIDAE), A NEW RECORD FROM CENTRAL AUSTRALIA

By G. F. Griffin

12 Cummings St, Alice Springs, N.T. 5750

A female of the dragonfly *Rhyothemis graphiptera* (Rambur) (Odonata: Libellulidae), was collected at Alice Springs, Northern Territory on 9 February, 1982. This species is widely distributed across northern and eastern Australia and is known from some inland areas (Watson 1974). However, specimens were not collected in past surveys at Tennant Creek (Tillyard 1908) or in central Australia (Griffin 1979).

A previously unreported sighting of an individual of this species was made near Alice Springs in December, 1975. At the times of the 1975 sighting and the 1982 collection, central Australia was being affected by northern monsoonal airflows. While the collected specimen was in remarkably good condition it seems likely to have had a northern origin.

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BOOK REVIEW

Insect neurohormones by Marie Raabe. 1922. Plenum Press, New York. 372 pages, Illustr. Price US\$42.50.

"The recent proliferation of investigations into insect neurohormones has created the need for an overall review of the data." (Preface). It is certainly true that neuro-endocrinology and endocrinology have occupied a large proportion of the literature of insect physiology over the last 25 years and all workers in the field will be grateful for a compilation of the data, as is provided in this book. Citation and summary of the literature dealing directly with neurohormones is exhaustive and up-to-date. However it is not possible to draw a precise functional line between the neurohormones and the endocrine processes controlled by many of them; treatment of the strictly endocrinological aspects of these systems would allow for a more balanced overall picture but no doubt would have made the book too big. The book is particularly useful in drawing attention to the substantial and interesting French and German literature on neuro-endocrinology, much of which is less familiar to English-speaking workers.

I suppose one naturally turns first to the part of a book concerned with one's own field of research. Mine is aphid polymorphism and I found the treatment disappointing and to some extent misleading. Since the cited authors (Lees and Hardie) have been at pains to disclaim any relationship between juvenile hormone and alate/apterous dimorphism, I don't think they'll be very pleased to find their work summarised as "Experiments with topically applied juvenile hormone extracts and analogues seemed to divert alate development towards the apterous condition." In the next paragraph the work of Colin Steel on parthenogenetic/sexual dimorphism in aphids is summarised accurately enough but with no feeling of the utter technical brilliance of Steel's achievement. Perhaps the lesson (if we needed it) is that one should not put one's faith in the secondary literature for either fact or atmosphere.

It's an exciting time in insect neuroendocrinology, passing from the purely descriptive/physiological to the biochemical level of investigation, with fascinating parallels with vertebrate endocrinology. Perhaps it's the fault of the translation in part, but this book doesn't seem to capture the essence of present day research. A critical synthesis is not attempted and there is a single paragraph "speculating on future trends and progress" The book remains a useful compilation of the literature, but it's not the answer to "life, the universe and everything" in insect neuroendocrinology.

DINAH HALES

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Compiled by M. S. and B. J. Moulds

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COVER

Illustrated by Stephen Underwood

The Bentwing Swift Moth, *Zelotypia stacyi* Scott (family Hepialidae) is one of Australia's largest moths with species often having a wing span in excess of 230 mm. Adults are tawny brown with silver-white markings and the spectacular raised eye spot gives the fore wing the appearance of a reptilian head. The larvae feed on only a few species of eucalypt including the Sydney blue gum, *E. saligna*, and grow to some 130 mm over a period of 5-6 years. The species occurs in south-eastern Queensland and eastern New South Wales. It is now exceedingly rare in New South Wales.

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OBSERVATIONS ON *SCARAPHITES ROTUNDIPENNIS* (DEJEAN) (COLEOPTERA: CARABIDAE) A PEST OF GOLF COURSES ON FLINDERS ISLAND

By P. B. McQuillan

Division of Entomology, Department of Agriculture Laboratories, St John's Avenue,
New Town, Tasmania, 7008.

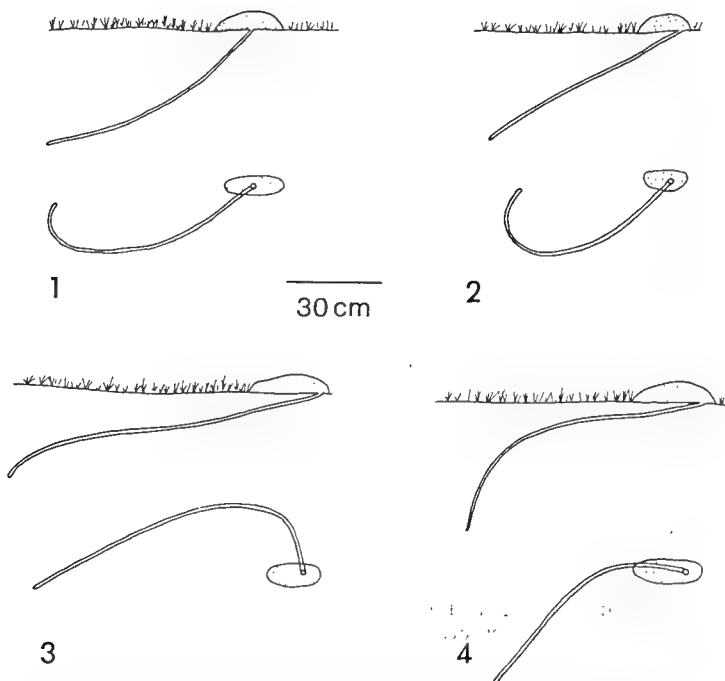
Abstract

On Flinders Island, adults of the carabid *Scaraphites rotundipennis* (Dejean) excavate extensive tunnels in search of the larvae of scarab beetles, especially the dynastine *Pimelopus* sp., and the melolonthines *Scitala sericans* Erichson and *Phyllotocus* sp., upon which they feed. Mounds of excavated soil thrown up by this tunnelling activity interfere with play on local golf courses. Some details are given of the feeding behaviour of the beetles.

Introduction

Little is known of the feeding habits of adult scaritine carabids in Australia (Britton, 1970). In May 1980, a population of the large flightless predatory beetle *Scaraphites rotundipennis* (Dejean) was located at Whitemark golfcourse on Flinders Island in Bass Strait after complaints from the greenkeeper regarding insect damage to greens and fairways. The opportunity was therefore taken to make both field and laboratory observations on the feeding behaviour of the beetles.

Flinders Island has a temperate maritime climate; mean annual rainfall at Pat's River near Whitemark is 778 mm with a mean annual minimum and maximum temperature of 9.4°C and 17.4°C respectively (Bureau of Meteorology, 1975). The Whitemark golfcourse is located behind coastal dunes on the S.W. margin of the Island. The soil is mainly deep, slightly calcareous sand of the Lackrana association (Dimmock, 1957) with little profile differentiation other than accumulation of organic matter to about 25 cm. Particle size range is about 68% coarse sand, 31% fine sand and 1% silt and clay (Graley, 1956). Soil-dwelling insects were most abundant in hollows adjacent to the fairways and areas near remnant patches of open coastal heath consisting of *Acacia sophorae*, *Leptospermum* spp. and *Leucopogon* sp. with an understorey of *Poa australis*, *Scirpus nodosus* and *Meuhlenbeckia* sp.



Figs 1-4. Burrows of four specimens of *Scaraphites rotundipennis* shown in profile (upper) and plan (lower); Whitemark Golfcourse, 30 May 1980.

Methods

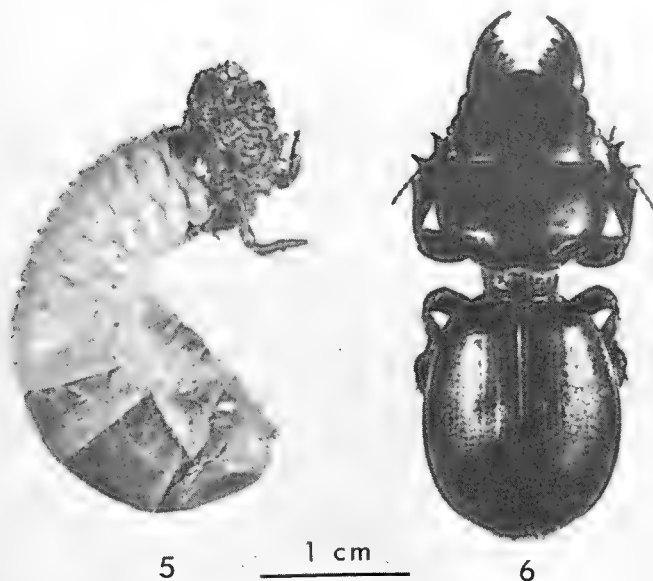
The density of burrows was measured by direct counting of soil mounds in areas 10 m x 10 m taken at random in areas of beetle activity. The entrance of a burrow was located by running a finger along the ground under its mound. Inserting a length of thin plastic tubing allowed the dimensions of the mound to be defined after careful excavation.

The density of other soil macrofauna was assessed by taking 30 random 0.25 square metre core samples to a depth of 25 cm and hand-sorting in the field.

The behaviour of four adult beetles was observed over five days in captivity by introducing solitary beetles into perspex observation boxes 45 cm x 30 cm x 2 cm containing soil from the collection site and 10 final instar larvae of the melolonthine *Scitala sericans* Erichson. Temperature was maintained at $22 \pm 2^\circ\text{C}$.

Results

Burrows were irregularly distributed over the golf course and densities per 100 square metres ranged from 11-78 ($\bar{x} \pm \text{SE} = 38 \pm 7$; $n = 14$).



Figs 5, 6. (5) a partially-eaten final instar larva of *Pimelopus* sp. recovered from a feeding burrow; (6) adult *Scaraphites rotundipennis* in death-feigning pose.

Beetles excavated deep burrows for shelter and in search of prey. The location of a burrow was marked by a large mound of excavated soil which, at Whitemark, interfered with golf. Burrows (Figs 1-4) were generally curved in plan, 70-100 cm long and descended obliquely to a depth of 30-35 cm.

Beetles were generally found in the lower 10 cm of the burrow although two were found in the upper 15 cm. Upon exposure the beetles adopted a death-feigning attitude (Fig. 6). Not all burrows were occupied; of 34 excavated, only eight, or 24% contained a beetle.

At least four species of third-instar scarabaeid larvae inhabited the area. In decreasing order of biomass these were the dynastine *Pimelopus* sp., the melolonthine *Scitala sericans* Erichson, the aphodiine *Aphodius tasmaniae* Hope and the melolonthine *Phyllotocus* sp. Mean larval densities per square metre \pm SE ($n = 30$) were estimated at 6 ± 3 , 4 ± 3 , 10 ± 4 and 3 ± 2 , respectively. *Pimelopus* larvae were most abundant in areas where live and dead *Meuhlenbeckia* rhizomes and roots were present.

The remains of scarabaeid larvae were recovered from one third (11 of 34 excavated) of the burrows, generally in the upper 20 cm of the burrow. Nine contained *Pimelopus* only, one contained *Scitala sericans* only and both species were located in another. Larvae characteristically had the head and

thorax consumed, the remainder being uneaten (Fig. 5). Since the abdomen of larval scarabs contains mostly semi-digested organic matter and soil particles it may be unpalatable to *Scaraphites*.

Beetles introduced to observation boxes immediately burrowed vertically against an end wall until they reached the bottom. However, during the night beetles moved to the surface and dug oblique burrows which intercepted *Scitara* larvae. Each beetle dug a new burrow every one or two nights. Actual feeding was not observed but after five days all larvae had been partly devoured.

Discussion

Scaraphites rotundipennis appears to be an important predator of scarab larvae where it occurs. The well-developed burrowing ability of the beetles and presumably their larvae, would result in a high searching efficiency. It is likely that the larvae of scarab beetles are an important component in the diet of many burrowing carabids generally. For example, *Barypus clivinoides* Curtis preferentially feeds on scarab larvae in Patagonia (Ahmad & Lloyd, 1972) and a South African *Scarites* sp. can consume at least one, and up to three, large larvae of the dynastine *Heteronychus arator* (F.) per day (Cameron *et al.*, 1979). Like other large carabids (Thiele, 1977) adult *Scaraphites* may live several years and populations are probably of long standing.

In spite of a high consumption of scarab larvae, the low population density, low vagility and probable low fecundity of *Scaraphites rotundipennis* would not seem to favour its use as a biological control agent for root-feeding cockchafers in pastoral situations.

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The late Mr W. P. Calvert provided able assistance in the field. Mr R. J. Hardy and Dr B. P. Moore gave helpful comments on the manuscript. Mr P. Warren drew my attention to the problem.

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THE FOOD OF ADULT OSMYLIDAE: KEMPYNINAE (NEUROPTERA)

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Abstract

Examination of gut contents of Kempyninae showed that they take a wide range of foods, sometimes with a preponderance of plant material. This includes pollen, fungal hyphae and spores, and fragments of foliage and bark.

Adult Osmylidae have generally been assumed to be predators, in common with those of other groups of Neuroptera for which little biological information is available. Direct evidence for this habit is sparse, and is almost wholly limited to fragmentary observations on the single European species [*Osmylus fulvicephalus* (Scopoli)], which has been observed to take insect food (Ussing, 1915; Killington, 1936) although no detailed study of its feeding habits has been made. In this note evidence is presented that some of the more primitive Osmylidae take plant food as adults.

The subfamily Kempyninae contains some of the largest and most spectacular Osmylidae and, on some venational features (such as the basal position of the forewing MP fork—Adams, 1969) are considered to be a relatively primitive group. During recent revisionary work on the Australian representatives of Kempyninae, mid- and hind-gut contents of specimens dissected for genitalic examination were appraised. Following partial maceration in 10 per cent KOH, gut contents remaining in the abdomen were smeared in distilled water and examined microscopically. Twenty specimens, representing both described and undescribed species of *Kempynus* Navás and *Australysmus* Kimmins, yielded recognisable gut contents.

Fourteen specimens (six spp.) contained plant material of various sorts (Table 1) and only six (four spp.) yielded traces of animal (insect) prey. Only one specimen contained both categories of food. Both genera were represented in each category but, because some species are represented only by singletons, naming beyond this level is not helpful. For the few species of which several specimens were examined there appeared to be considerable individual variation in diet, and it is clear that individuals of the same species may eat different foods at different times. One individual of *Kempynus longipennis* (Walker) (five individuals examined) had the gut full of fungal hyphae, three others contained a mixture of foods which included hyphae, spores, pollen (Compositae, *Eucalyptus*) and bark flakes, and one had fed on insects. These categories, together with bark flakes, encompassed the foods of other taxa examined. Insect remains included adult moths, a small caterpillar, and psyllids. This broad food spectrum contrasts markedly with that of several

TABLE 1

Mid- and hind-gut contents of adult Kempyninae (total of 20 individuals: some entered in > 1 column; intermediate categories subjective; 'trace' = ca < 20%).

Total individuals	Food constituent	Number of individuals with proportion of gut contents*			
		Full	> 50%	> 20%	Trace
6	insects	2	—	1	3
7	pollen	—	3	3	1
7	fungal hyphae	1	3	1	2
5	spores	—	—	3	2
9	foliage fragments	—	—	5	4
6	bark fragments	—	4	—	2

* Percentages are visual estimates based on relative areas of slide-mounted gut smears for each individual.

myrmeleontoid families, in which equivalent gut preparations invariably showed only arthropod fragments (unpublished data), and implies that at least some Osmylidae are relatively polyphagous.

Osmylidae are generally presumed to fly relatively weakly. They have relatively broad wings and lack a wing-coupling mechanism and are probably not as 'efficient' as aerial predators as are some other groups of Neuroptera. Several species have been recorded in groups on vegetation near stream banks and similar habitats (Riek, 1970, for example). It is possible that this relatively inactive life style may favour general browsing rather than active searching for animal prey. Pollen-feeding is well-known in some Chrysopidae, but that association appears to be more intimate, as such species are not generally predatory as well. It seems that some Osmylidae may be amongst the most generalised feeders in the Neuroptera, and information on the effects of different foods on their reproductive biology would be of considerable interest.

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MIGRATION RECORDS IN AUSTRALIA. 4. PIERIDAE (LEPIDOPTERA) OTHER THAN *ANAPHAEIS JAVA TEUTONIA* (F.)

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Abstract

Information on migration in 12 of the 32 species of Pieridae occurring in Australia is summarised.

Introduction

This paper presents a summary of information available on migration of Australian Pieridae, other than *Anaphaeis java teutonia* (F.) for which there are many records and which will be dealt with more appropriately in a separate paper. Of the 32 species of this family in Australia 12 are here recorded as confirmed or likely regular migrants (*A. java* being a thirteenth); for some of the species there are very few records. Further observations are needed on all of them, especially those which have their main centre of distribution in Queensland and which occasionally extend their range southward by migratory flights.

Appias paulina ega (Boisd.)

Lucas (1887) records the "appearance" of this species at Balaclava, Victoria. Williams (1929) mentions a south-easterly migration at Westwood, Queensland, and (Williams 1930a) refers to a comment from Waterhouse that small flights occur in early autumn. Waterhouse (1932) mentions it as common in some areas near Sydney when it is migratory, and Barrett and Burns (1951) mention local flights resulting from breeding in enormous numbers in some seasons. Crosby (1963) records the species from Malacoota, Victoria. Rose (1972) records it from Ku-ring-gai National Park, N.S.W., in 1971. Table 1 gives recent unpublished records for this species.

The few records available suggest that the species occasionally extends its range by migration to the south, even as far as Victoria; this may occur frequently but only be noticed in periods of high population levels, mainly during December to February. Extension seems to have occurred on a noticeable scale in the summers of 1963, 1964, 1969 and 1971. Sankowsky (pers. comm.) noted at Goodnight Scrub (near Wallaville, SE Qld), that large numbers were in flight in December 1969 but were no longer present there three weeks later. This suggests possible emigration, perhaps similar to that on which Barrett and Burns (1951) based their comment mentioned above.

Catopsilia pomona pomona (F.)

Barnard (1883), Waterhouse (1932), Williams (1930a) and Barrett and Burns (1951) refer to the migratory habit of this species in general terms but despite this, and even though the species has the common name of "lemon migrant", there are remarkably few detailed records for such a

conspicuous and obviously migrant species. Hudson (1898) records a specimen from New Zealand. Williams (1929) mentions a south-easterly movement on 9th January 1924 at Westwood, Qld and Waterhouse (1932) a similar movement in January 1928 at Rockhampton, Qld. Moulds (1963, 1964) and Peters (1963) have listed specimens seen in the Sydney and Broken Bay (N.S.W.) areas during January, February and March in 1962 and 1963; where flight directions were recorded they were nearly all southerly or easterly. Fletcher (1953) reported an invasion of Heron Island by this species. More recent unpublished records are included in Table 2.

This species appears to behave in much the same way as *Appias paulina ega*; it probably has regular population movements within its northern breeding range with southerly extensions of the movements at certain times of year, mainly in December to February but occasionally earlier and later. Also, the years in which *A. P. ega* appears to have made extensive southern invasions coincide mainly with the major southerly extensions of this species.

The observations of J. N. Yates at Caloundra, Qld, are the most detailed available. Southerly movements were noted from 22nd February to 9th March 1981, the insects flying at heights between 2-7 metres from 11.00 hrs to 17.00 hrs. Numbers were greatest around midday but flights ceased during overcast and rainy periods. Movement appeared to be in narrow "streams", a feature often seen in population movements of *Anaphaeis java teutonia*.

The greatest numbers were observed on 4th March when the following numbers were counted over a 30 m front:

Time (eastern standard)	No. of specimens
12.55-13.00	209
13.00-13.05	201
13.05-13.10	204
13.10-13.15	172
13.15-13.20	199
13.20-13.25	185
13.25-13.30	203
Total 35 mins	1373

Between 4th and 9th March the migration continued but in reduced numbers. Despite the magnitude of the southerly movement at Caloundra there were no reports of the migrations continuing as far south as New South Wales.

Catopsilia pyranthe crokera (W. S. Macleay)

Williams (1929) records this species as occurring in Melbourne in April and Waterhouse (1932) and Common and Waterhouse (1972, 1981) mention immense flights in Queensland at irregular intervals, with a general direction from north to south and that they reach Sydney but rarely Melbourne. Waterhouse and Lyell (1914) record a southerly movement in Sydney in February 1895 and Williams (1930a) records a flight of about 100/hr passing through a garden in Killara, N.S.W., from 5th March to about 10th April,

TABLE 1
Records of migration of *Appias paulina ega*

Locality	Date	Direction	Observer
Kariong, N.S.W.	10.ii.1964	SSW	M. Burnell
Thornleigh, N.S.W.	6-30.xi.1964	SSW/NE	M. R. Long
Turramurra, N.S.W.	21.xii.1969	S	C. N. Smithers
Childers-Maryborough, Q.	xii.1969	NW	G. Sankowsky
Bellingen River, near Thora, N.S.W.	i.1971	E	M. S. Moulds
Lorn, Maitland, N.S.W.	i-ii.1971	occasional specimens	A. D'Ombrain
Ryde, N.S.W.	1.ii.1971	S (few specimens)	J. V. Peters
Yallourn, V.	25.ii.1971	1 specimen	H. Crane
Wahroonga, N.S.W.	28.ii.1971	1 specimen	A. B. Rose

TABLE 2
Records of migration of *Catopsilia pomona pomona*

Locality	Date	Direction	Observer
Seven Hills, N.S.W.	21.i.1962	—	J. V. Peters
Toowoomba, Q.	23-24.xi.1964	E	M. Russell
Mackay-Rockhampton, Q.	8.i.1970	N 20-30/min	W. Frost
Menangle Park, N.S.W.	15.xi.1970	appearance	E. O. Edwards
Colo River, N.S.W.	16.xii.1970	appearance	J. V. Peters
Bayview, N.S.W.	10-17.xii.1970	N	L. C. Haines
Ku-ring-gai Chase and Pymble, N.S.W.	16.xii.1970	SW	J. V. Peters and M. S. Moulds
Wahroonga, N.S.W.	19.xii.1970	appearance	A. B. Rose
Maitland, N.S.W.	i-ii.1971	appearance	A. D'Ombrain
Turramurra, N.S.W.	15.ii.1971	appearance	C. N. Smithers
Ku-ring-gai Chase, N.S.W.	9-20.viii.1971	appearance	A. B. Rose
Wahroonga, N.S.W.	xi.1972	appearance	A. B. Rose
Caloundra, Q.	22.ii-9.iii.1981	S (see text) 5/min/30 m.	J. N. Yates

1928. This species is such a well known migrant that it is referred to as the "common migrant" but, like *C. pomona*, details of the migrations are very few. Recent unpublished records are presented in Table 3.

The data so far available suggests that *C. pyranthe* has a migration pattern similar to that described above for *C. pomona* and *A. paulina*; large scale movements occurred in early 1971, at which time these species were also very actively moving. In that year flights of *C. pyranthe* started with a few specimens in late February and early March. Numbers were greatest on 19th

March after which fewer were seen, with the main flight virtually ending at about the end of March although a few specimens were seen at Gloucester as late as 21st April.

Cepora perimale scyllara (W. S. Macleay)

Common and Waterhouse (1972, 1981) mention one specimen from Nowra, N.S.W., and one from near Melbourne of this otherwise common northern species. It occasionally appears in Sydney but is seldom seen south of Newcastle. If this species is a migrant within its range it certainly does not make the regular extensions to the south which are seen in the *Catopsilia* spp.

Delias aganippe (Don.)

There is only one observation of massed flight in this species, a very spectacular NNW movement at Long Reef Golf Course, Sydney, N.S.W., on 2.xii.1969 (obs. J. V. Peters, M. S. Moulds, C. N. Smithers). On 20th May 1970 three specimens were seen on Erskine Island, Capricorn Group, Qld but neither before nor afterwards. The conclusion reached was that the specimens must have come from adjacent coastal areas (Reeves 1971). This species is known to congregate in numbers, as at Nar Nar Goon, Victoria, in December 1970 (obs. K. Reid) but whether such aggregation is associated with population movement is not known.

Delias harpalyce (Don.)

Williams (1929) reports annual westerly movement of this species in Victoria. One specimen has been seen about 12 km from Gabo Island, off the coast of Victoria (obs. A. S. Angus). Aggregations have been reported from Nar Nar Goon, Victoria, in December 1970 and March 1971 (obs. K. Reid) (see also comment under *Delias aganippe* above).

Delias nigrina (F.)

Olliff (1889) mentions that this species is a migrant but does not give details. Waterhouse (1932) states categorically that it is not a migrant.

There are, however, recent detailed observations which suggest that it does undertake northerly flights, mainly in April/May; perhaps these are short distance flights. These observations are listed in Table 4.

Eurema brigitta australis (Wallace)

Peters (1969) gives two records of this species from notes by G. A. Waterhouse in the Australian Museum (15th April 1934 at Killara, N.S.W. and 14th April, 1950 at Clifton, N.S.W.) and a third from his own observations at Lindfield, 11th February 1962. These occurrences, all in Sydney, suggest possible infrequent summer or autumn movement into the area, the usual southern end of its range is further north at about the Richmond R, south of which Common & Waterhouse (1981) mention the species as being sporadic.

Eurema hecabe phoebus (Butler)

Dodd (1955) records a northerly flight of tens of thousands over the sea near Bowen, Qld. Williams (1929) mentions flights with *E. smilax* and Rose

TABLE 3
Records of migration of *Catopsilia pyranthe crokera*

Locality	Date	Direction	Observer
Botany, N.S.W.	ii.1962	SW (hundreds seen)	R. Mascord
Lindfield, N.S.W.	20.ii-3.iii.1963	several seen	J. V. Peters
Ku-ring-gai Chase N.S.W.	12-31.iii.1971	S 25/30min/100m (on 19.iii.1971)	A. B. Rose
Ryde, N.S.W.	20.iii.1971	small numbers	J. V. Peters
Wagga Wagga, N.S.W.	22.iii.1971	appearance	P. Bungay
Camden, N.S.W.	25.iii.1971	S, SW, SSW	C. N. Smithers, M. S. Moulds G.A. Holloway
Gloucester, N.S.W.	21.iv.1971	appearance	A. B. Rose
Ryde, N.S.W.	10.iii.1973	appearance	J. V. Peters
48 km N Singleton, N.S.W.	5.iv.1981	S one specimen	C. N. Smithers

TABLE 4
Records of migration of *Delias nigrina*

Locality	Date	Direction	Observer
Kempsey and Hatt Head, N.S.W.	16-20.v.1967	NW 120/min flying out to sea	B. Brown
Sawtell, N.S.W.	20.iv.1964	N 35/min/50m	P. J. Wilson
Sawtell, N.S.W.	27.iv.1968	N 1/min/50m	P. J. Wilson
Sawtell, N.S.W.	3.v.1968	2/min/50m	P. J. Wilson
Hastings Point, N.S.W.	28.viii.1969	N few specimens	H. J. de S. Disney
Scott Head to Nambucca, N.S.W.	25-26.iv.1976	N small nos.	P. J. Wilson

(1972) mentions its occurrence in Ku-ring-gai Chase, Sydney, N.S.W., in February 1971. Fletcher (1973) reported an invasion of Heron Island, Qld, on 4th and 5th January 1971. On April 8th and 10th 1971 a SE movement involving many specimens was noted at Coorabell, near Byron Bay, N.S.W. (obs. C. Trickett). On 20th-22nd April 1971 a northerly movement was reported at Alstonville, N.S.W. The species had been common for several weeks before but did not appear to migrate until the 20th (obs. W. Wright).

It is interesting to note that Coorabell and Alstonville are about 20 km apart and that the flight directions recorded are almost opposite to one another. This suggests that a southerly movement was followed immediately by a northerly one; possibly the same specimens were involved.

Although not recording specific migration, comments by Rainbow (1907), Waterhouse (1932), Barrett and Burns (1951) and Moulds (1964) suggest southerly movement in autumn.

Eurema smilax (Don.)

Williams (1930a, 1930b, 1937), Upton (1949), Poulton (1933) and Barrett and Burns (1951) make general references to the migratory habits of this species. Anderson and Spry (1893) refer to it swarming.

Waterhouse and Lyell (1914) record a westerly migration in October 1894 at Gisbourne, Victoria, and Williams (1929) refers to a southerly migration at Woodford, N.S.W., from 21st April to 4th May 1906 in which specimens were passing at 50/hr. The flights were often accompanied by specimens of *E. hecabe* and *E. herla* (W. S. Macleay). Alexander (1917) reports on a "flight" in south-western Australia in the summer of 1914-15. Fenselau (1977) reported the species moving south at Sealake, Victoria, at the end of August 1977, a year in which many reports of southerly migration were received (see Table 5). Unpublished records accumulated since 1962 are presented in Table 5.

This species is clearly a regular migrant. Numbers are usually small, with individuals being widely separated; such small population movements are easily missed unless a special watch is kept. Movement is likely to take place at any time from December to April and the major movements are to the south. If northerly movements of even smaller numbers do take place, they would be hard to detect. The only northerly record is that for Barraba, N.S.W., on 1st December 1969 (obs. M. Showers).

It is interesting to note that the movement of 1977 started very suddenly with enormous numbers appearing in the Hunter Valley on 27th March at which time they also appeared in numbers at Stanwell Tops near Sydney (obs. G. Daniels).

Eurema herla (W. S. Macleay)

The only record of population movement in this species is provided by Waterhouse and Lyell (1914) who mention specimens accompanying a southerly flight of *E. smilax* at Woodford, N.S.W., from 21st April to 4th May 1906 (see also under *E. smilax* above).

Pieris rapae rapae (L.)

The history of the spread of this Palearctic species has been summarised by Peters (1970). It is well known as a migrant in Europe but little is known of population movements in Australia, there being only one observation reported of a northerly movement on 12th October 1970 at Box Hill, Footscray and Brooklyn, Victoria, when a count of 80-160/hr was made (obs. A. Riddell).

Acknowledgements

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TABLE 5
Records of migration of *Eurema smilax*

Locality	Date	Direction	Observer
Seven Hills, N.S.W.	20.i.1962	S	J. V. Peters
Lindfield, N.S.W.	11.ii.1962	S	J. V. Peters
Lindfield, N.S.W.	19.i.1963	S	J. V. Peters
Lindfield, N.S.W.	iii.1963	S	J. V. Peters
Ryde, N.S.W.	6.i.1964	S	J. V. Peters
Ryde, N.S.W.	25.ii.1967	S	J. V. Peters
Ryde, N.S.W.	2.iii.1968	S	J. V. Peters
Razorback, N.S.W. (near Camden)	22.xi.1968	S	J. V. Peters
Camden, N.S.W.	25.x.1969	S	J. V. Peters
Barraba, N.S.W.	1.xii.1969	N	M. Showers
		great numbers	
Ryde, N.S.W.	20.xii.1969	S, SW	J. V. Peters
Ryde, N.S.W.	1.ii.1971	S	J. V. Peters
Castle Hill, N.S.W.	17.x.1971	S	J. V. Peters
Moss Vale, N.S.W.	24.x.1971	S	J. V. Peters
Mt. Wilson, N.S.W.	12.ii.1972	S	J. V. Peters
Ryde, N.S.W.	10.iii.1973	S	J. V. Peters
North Turramurra, N.S.W.	10.iii.1973	S	C. N. Smithers
Ryde, N.S.W.	19.iii.1973	S	J. V. Peters
20km N Singleton, N.S.W.	27.iii.1977	S	C. N. Smithers
Stanwell Tops, N.S.W.	27.iii.1977	1/min/50m appearance in numbers	G. Daniels
Sydney, N.S.W.	29.iii.1977	S	G. Daniels
Sydney, N.S.W.	30.iii.1977	S	C. N. Smithers
Round Hill Reserve, N.S.W.	9.iv.1977	SW	G. Daniels
Condobolin to Cudal, N.S.W.	11.iv.1977	S	G. Daniels
48km N. Singleton, N.S.W.	12.iv.1977	S	C. N. Smithers
48km N. Singleton, N.S.W.	16.iv.1977	S	C. N. Smithers
Sydney, N.S.W.	17.iv.1977	S	G. Daniels
Sydney, N.S.W.	9.iii.1979	S	G. Daniels
Engadine, N.S.W.	10.iv.1979	1 specimen seen	G. Daniels

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A MUTANT STRAIN OF *HELIOTHIS ARMIGER* (HÜBNER) (LEPIDOPTERA: NOCTUIDAE) DETECTABLE IN LARVAL AND ADULT STAGES

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Abstract

A mutant strain of *Heliothis armiger* (Hübner) was detected in a culture from Narrabri, New South Wales. Abnormal larvae differed in colour from the wild type and produced adults with bright yellow eyes.

Heliothis armiger (Hübner) is a major agricultural pest in Australia. There are usually six larval instars. Normally, up to the fourth instar, larvae vary through shades of brown to black in colour with black setae and setal plates. As well, the thoracic legs and abdominal prolegs have black segments and from the third instar onwards, a darkly pigmented dorsal saddle on the first abdominal segment is evident. In the last two instars considerable larval colour variation can occur from yellow-green, green, pink to brown. Individual larvae may change colour from instar to instar. The reasons for this later instar colour morphs are not clear, but Whitlock (1972) has established that variations are not hereditary. This note reports the finding of *H. armiger* larvae which, from the third instar onwards, were abnormally coloured and which developed into adults with mutant eye colour.

Our abnormal larvae (from a Narrabri, New South Wales culture) were easily picked out early in the third instar; they were a light green which contrasted sharply with the black legs, setae and setal plates. The dorsal saddle was not present. Later instars (5th and 6th) of these larvae were a little darker green, providing less of a contrast and a dorsal saddle was present.

The abnormal larvae were selected from the main culture and allowed to complete their development separately. On emergence as adults, both males and females were found to have bright yellow eyes. Normally, *H. armiger* moths have brownish green eyes. Although mutant *H. armiger* with abnormal eye colour have apparently not been previously reported, a yellow-eyed mutant is known in *Spodoptera littoralis*, (Dittrich and Leutkemeier, 1980).

We attempted to breed from the mutant moths (approximately 20) but their eggs failed to hatch. We are not sure whether winter photophases inhibited mating or whether sterility accompanied the abnormality in the moths.

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THE EARLY STAGES OF *RAPALA VARUNA SIMSONI* (MISKIN)
(LEPIDOPTERA: LYCAENIDAE) FROM
SOUTH-EASTERN QUEENSLAND

By T. A. Lambkin

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Abstract

The immature stages of *Rapala varuna simsoni* (Miskin) are described and other notes on the life history recorded.

Introduction

The Indigo Flash, *Rapala varuna simsoni* (Miskin) is found in New Guinea, throughout the islands of Torres Strait and along the east coast of Queensland from Cape York to Yeppoon, with records from Cooran Tableland and from Brisbane (Common and Waterhouse, 1981). It occurs in a wide variety of habitats from dry open sclerophyll forest to wet rainforest.

The life history for this subspecies has not previously been recorded although Atkins (1975) lists *Alphitonia excelsa* Reissek, as a food plant and Storey (1977) has reared larvae from the flowers of the introduced Litchi (*Litchi chinensis*). During March and April 1981, adults and immature stages were common on a small number of *A. excelsa* trees growing in the Department of Primary Industries complex at Indooroopilly, Brisbane. A number of various instar larvae were collected and nine of these were subsequently reared to adults in Brisbane.

Life History

EGG (Fig. 1)

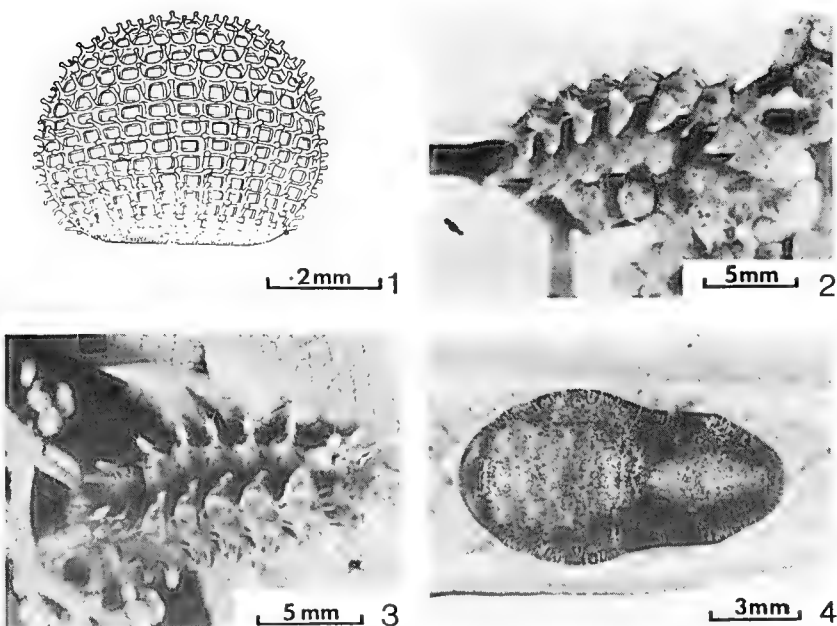
Pale, turning to black just prior to emergence; sub-spherical, with flattened base and depressed apex; micropylar area smooth. Remainder of surface reticulate with truncate projections at intersections of ridges. Diameter 0.4 mm; height 0.3 mm.

FIRST INSTAR LARVA

Head large, pale brown. Thorax and abdomen white; covered with long colourless primary setae; with a pair of subdorsal setae, much longer than the rest, on each of the prothorax, mesothorax and abdominal segment 7.

LAST INSTAR LARVA (Figs 2, 3)

Head pale brown; covered by prothorax. Prothoracic plate pale yellow-green with a pair of dark red patches, covered with secondary setae and with subdorsal and lateral raised humps. Mesothorax and metathorax with dorsal surface pale yellow-green with a median dark green line; lateral surface dark green with a white curved line. Both meso- and metathorax each with a pair of subdorsal and lateral tooth-like projections, these projections being white with an orange base and bearing colourless secondary setae. Abdominal



Figs 1-4. *Rapala varuna simsoni* (Miskin); (1) egg, lateral view; (2) final instar larva on flower bud; (3) dorsolateral view of final instar larva; (4) pupa, dorsal view.

segments similar in colour to thoracic segments, abdominal segment 7 with a pair of dark red patches; segments 1-6 each with tooth-like projection similar to those of metathorax, those of segment 1 dark red, joined laterally by a red band, those of remaining segments white with orange bases. Anal plate pale yellow-green, ringed laterally by 6 white projections. Length 16.7 mm; width 5.3 mm. Prepupa red-brown.

PUPA (Fig. 4)

Pink and white initially, then changing to pale brown with head and thorax marked with black-brown, wing cases black-brown, abdomen blotched with dark brown squares and with last segment ringed with black-brown; surface quite smooth, covered with minute pale brown setae; attached to silken pad by anal hooks and central girdle. Length 11.3 mm; width 6.0 mm.

NOTES

Eggs are laid singly on flower buds, flowers and young green stems. First instar larvae burrow into the flower buds and feed internally. Later instars feed openly on the flowers and because of their shape and coloration are extremely difficult to locate. Pupae were not found in the field, but those of the bred specimens occurred on either the upper or lower surfaces of the leaves of the food plant. Pupal duration was 10 to 11 days. The immature stages were not attended by ants and parasitism was not recorded.

Adults of both sexes were on the wing as early as 8 a.m. (Eastern Standard Time) and some were still flying as late as 4 p.m. After midday males established territorial boundaries by flying in circular patterns from their roosting positions in eucalypt trees to the food plants then back again. Females spent the day either feeding on the *Alphitonia* blossom or ovipositing.

In the Brisbane area, *A. exelsa* usually flowers during April and May and in dry seasons flowering does not occur. The food-plant trees during 1981 commenced flowering as early as February and continued through to April. *R. varuna* is normally rare in the Brisbane area, and the coincidence between its relative abundance this year and the early flowering of its food plant is most interesting.

Acknowledgements

I wish to thank Mr D. Ironside for the colour transparencies of the immature stages, Mr R. J. Corcoran for the black and white prints from the transparencies and Mrs S. Sands for the line drawing of the egg.

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OGYRIS AMARYLLIS AMATA WATERHOUSE (LEPIDOPTERA: LYCAENIDAE) TENDED BY CAMPONOTUS ANTS

By D. J. Ferguson

Research School of Biological Sciences, P.O. Box 475, Canberra City, A.C.T. 2601

In September 1981, while searching for the early stages of *Ogyris amaryllis amata* at Coppins Crossing on the Molonglo River, Australian Capital Territory, twelve late-instar larvae and pupae were found in a hollow of a decayed branch stump. These were actively tended by a number of sugar ants *Camponotus* sp. Although *O. amaryllis amata* is known to be tended by *Iridomyrmex* ants (Common and Waterhouse, 1981), it has not previously been reported that *O. amaryllis* is also tended by *Camponotus* ants. Both *Iridomyrmex* and *Camponotus* ants were tending the *O. amaryllis amata* larvae and pupae at Coppins Crossing, even on the same tree, but at no time were the two ants observed co-attending at the same sites.

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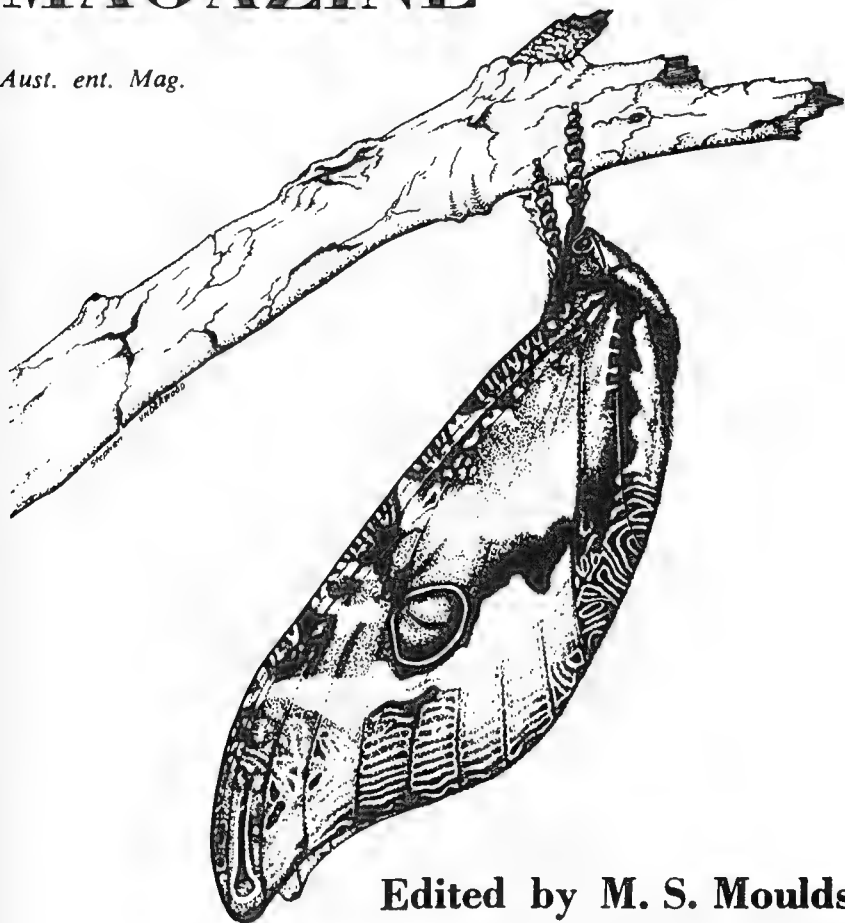
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COVER

Illustrated by Stephen Underwood

The Bentwing Swift Moth, *Zelotypia stacyi* Scott (family Hepialidae) is one of Australia's largest moths with species often having a wing span in excess of 230 mm. Adults are tawny brown with silver-white markings and the spectacular raised eye spot gives the fore wing the appearance of a reptilian head. The larvae feed on only a few species of eucalypt including the Sydney blue gum, *E. saligna*, and grow to some 130 mm over a period of 5-6 years. The species occurs in south-eastern Queensland and eastern New South Wales. It is now exceedingly rare in New South Wales.

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A NEW SPECIES OF *LASIOPSOCUS* ENDERLEIN (PSOCOPTERA: PSOCIDAE) FROM NEW SOUTH WALES

By C. N. Smithers

The Australian Museum, 6-8 College Street, Sydney

Abstract

Material recorded as *Blaste michaelsoni* (Enderlein), from Muogamarra Nature Reserve, near Sydney (Smithers, 1977) has been re-examined and found to represent a new species. This is described as *Lasiopsocus simulatus* sp.n.

Introduction

During work on a collection of Psocoptera from South Australia it was necessary to examine again a specimen from Muogamarra Nature Reserve, New South Wales, which had been identified as *Blaste michaelsoni* (Enderlein) (Smithers, 1977) because undoubted material of that species now available raised some doubt as to the reliability of the earlier identification. The identification has been found to be in error and the specimen is now regarded as belonging to an undescribed species. In order to validate the name prior to publication of studies on the South Australian material it is described here as *Lasiopsocus simulatus* sp. n. Originally described as a genus by Enderlein (1907) *Lasiopsocus* was placed as a subgenus of *Blaste* Kolbe by Roesler (1944).

Lasiopsocus simulatus sp. n.

Blaste michaelsoni (Enderlein). Smithers, 1977, *Rec. Aust. Mus.* 31(7):282 (nec Enderlein 1907).

Types. NEW SOUTH WALES: 1 ♂ (holotype), ex *Eucalyptus* sp., Muogamarra Nature Reserve, 1.viii.1974, C. N. and A. S. Smithers. In the Australian Museum. This specimen was previously recorded as *Blaste michaelsoni* (Smithers, 1977).

MALE

Coloration (in alcohol). Very similar to *L. dicellus* Smithers. Head pale, but brown as follows: a double row of irregular confluent spots adjacent to each compound eye, across back of vertex and on either side of median epicranial suture; a broad spot on frons anterior to ocelli; a line in position of anterior arms of epicranial suture from ocelli to antenna base; a ring around antenna base; a mark below compound eye on gena; postclypeal stripes and the labrum. Median postclypeal stripes closer and darker than lateral stripes. Ocellar tubercle black. Scape and pedicel brown; flagellum very dark brown. Eyes black. First and second maxillary palp segments pale, third brown, fourth dark brown. Dorsum of mesothorax dark, shiny brown, a little paler where parapsidal sutures meet. Fore legs pale brown, except for darker apex of tibia and tarsal segments. Meso- and metathoracic legs similar but coxae dark brown. Fore wings hyaline, without pattern; pterostigma brown; veins dark brown. Hind wings hyaline; veins brown. Abdomen pale, terminal structures very dark brown.

Morphology. Length of body: 3.6 mm. General morphology, size and appearance very similar to *L. dicellus*. Length of flagellar segments: f_1 : 1.2 mm.; f_2 : 0.96 mm. Eyes fairly large but not reaching level of vertex. IO/D: 1.9; PO: 0.91. Measurements of hind leg: F: 1.20 mm.; T: 2.40 mm.; t_1 : 0.56 mm.; t_2 : 0.16 mm.; rt: 3.5: 1; ct: 22, 2. Fore wing length: 5.3 mm.; width: 1.5 mm. Hind wing length: 4.0 mm.; width: 1.3 mm. Venation as in *L. dicellus*. Epiproct and associated structure (fig. 4) similar to those of *L. dicellus* but dorsal flaps a little narrower and the lobe which lies over the epiproct has straight sides and is a little wider apically. Ventroposterior extension of the ninth tergite with dorsal side of apex more pointed (fig. 3). Hypandrium (fig. 1) similar to that of *L. dicellus* but with a more rounded hind margin (transverse in *L. dicellus*). Phallosome (fig. 2) similar to that of *L. dicellus* but distal teeth relatively longer.

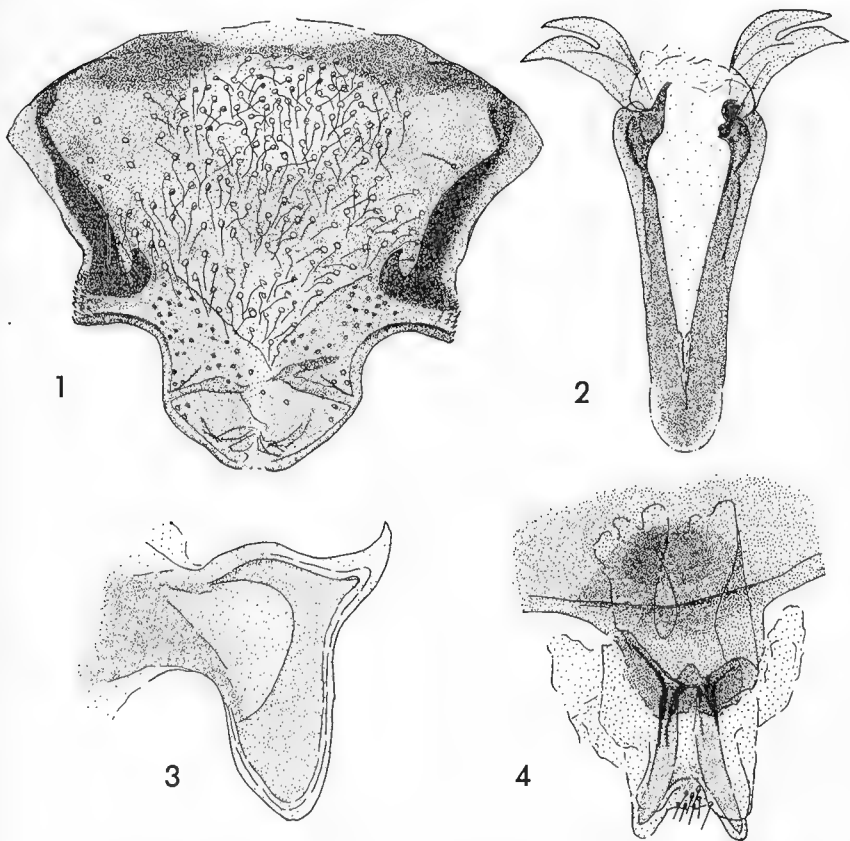
FEMALE

Unknown, but probably has patterned wings.

Discussion

L. simulatus differs from *L. michaelsoni* Enderlein, the type species of the genus from Western Australia, in being smaller and darker, with a fore wing length of less than 6 mm as opposed to 7 mm in *L. michaelsoni*. The wing setae are large and conspicuous in *L. michaelsoni* but small and inconspicuous in *L. simulatus*. The structures associated with the epiproct differ in proportions and the arms of the phallosome are narrower in *L. michaelsoni* than in *L. simulatus*.

L. dicellus Smithers, from South Australia, and *L. simulatus* are very similar to one another and it is possible that the minor differences in the form of the hypandrium (hind margin in particular), phallosome (proportions of parts) and structure associated with epiproct (proportions of structures)



Figs 1-4. *Lasiopsocus simulatus* sp. n.: (1) hypandrium; (2) phallosome; (3) ventro-posterior extension of ninth tergite; (4) epiproct and associated structures.

are not indicative of specific difference. On the other hand *L. dicellus* paratypes from South Australia do not show proportions similar to the single specimen from Muogamarra Nature Reserve. For the present, therefore, it is considered that they are two very closely related species differing but slightly in the proportions of their terminal abdominal structures.

Acknowledgement

I would like to thank Martyn Robinson for preparing the illustrations to this paper.

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A CAUTIONARY NOTE ON THE USE OF OVIPOSITION RECORDS AS LARVAL FOOD PLANT RECORDS

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Abstract

Butterflies may lay their eggs on species of plant which are unsuitable as sources of food for their larvae. This has led to some misleading records in the secondary literature. This contention is illustrated by detailed treatment of three examples: *Euploea core*/*Asclepias* spp., *Cressida cressida*/*Aristolochia elegans* and *Danaus plexippus*/*Araujia hortorum*. The reasons why such 'mistakes' in oviposition occur and their coevolutionary history is discussed.

Introduction

Comments received recently from a journal referee prompt us to point out the care which must be taken in using the presence of eggs of particular species of insects on a plant, as evidence that the plant is necessarily to be considered a food plant for the insect. This seems to be an especially pertinent problem when the insect or the plant or both are recent arrivals in the region concerned. Records based on observations of eggs or early instar larvae which, unbeknown to the observer, fail to develop, frequently get into the secondary literature such as hand-lists and field guides. The authors of such works, of course, must use published food plant records and are not in a position to check out all of them themselves, especially as this may require extended periods of observations to resolve the questions we raise here. It is therefore, a case of *caveat emptor* as far as the entomologist using such information is concerned. We illustrate this contention with three case histories from our own work or that of our colleagues on the ecology of butterflies.

Case 1: *Euploea core* Cramer and *Asclepias* spp.

In extended studies of the oviposition dynamics of *Danaus plexippus* L. and *D. chrysippus* L. we monitored eggs laid on patches of *Asclepias fruticosa* L. (Zalucki and Kitching, 1982). Throughout our period of observation, the highly distinctive globular eggs of *Euploea core* occurred regularly on our sentinel plants. Common and Waterhouse (1981) and Fisher (1978) record "*Asclepias* spp." as a food plant for both *E. core* and its congener *E. eichhorni* Staudinger. We followed the subsequent progress of these eggs throughout a season, and although they hatched, on no occasion did we find feeding larvae on the plants. In our experience, then, there seems no reason to include *Asclepias* spp. as food plants of *E. core* although they do provide a way of monitoring the egg-laying phenology of the species (Kitching and Zalucki, 1981). Casual observations suggest that *A. curassavica* L. and *A. physocarpa* (E. Mey) Schlecht may act in the same way as *A. fruticosa*. The species of *Asclepias* concerned were introduced to Australia from the West Indies in the case of *A. curassavica* and from southern Africa in the case of the other two species (Everist, 1974). The range of *E. core* does not encompass either of these areas and one must suppose that the two species have not been in contact long enough for the processes of coevolution to have altered the behaviour patterns of the butterfly. It must be supposed, though, that the

visual and chemical signals emitted by *Asclepias* are very similar to those given out by acceptable food plants such as native *Parsonsia* spp. and the exotic oleanders, *Nerium* spp.

Case 2: *Cressida cressida* (F.) and *Aristolochia elegans* (Mast.).

The Dutchman's pipe vine, *A. elegans*, is a commonly-grown garden plant in subtropical parts of Australia. In extended observations, we have found that it is very attractive to ovipositing females of *Cressida cressida* and may be inundated with the bright orange eggs of the butterfly. Indeed, at peak periods of female activity, two plants kept under close observation had hardly a leaf of the current year's growth without one or more eggs. First instar larvae will not, in our experience, feed on this species and die if denied access to more acceptable food plants such as the native species, *A. indica* L., *A. pubera* R.Br. and *A. thozetii* F.Muell. *A. elegans* as "cultivated Dutchman's pipe", is listed as a food plant by Burns and Rotherhan (1969) although both Common and Waterhouse (1981) and McCubbin (1971) note its unpalatability. As in the case of *Asclepias* spp. and *Euploea*, *A. elegans* may act, nevertheless, as a useful tool in the study of the population dynamics of *Cressida cressida* females for which it may act as a 'supernormal' stimulus for oviposition (*sensu* Tinbergen, 1951).

Case 3: *Danaus plexippus* L. and *Araujia hortorum* Fourn.

The moth-plant, *Araujia hortorum*, is widely recorded as a food plant of *Danaus plexippus* (Common and Waterhouse, 1981; McCubbin, 1971; Fisher, 1978; D'Abrera, 1971). In experiments in which we offered female *D. plexippus* a choice of plants on which to oviposit only 14 of a total of 824 eggs were laid on *A. hortorum* when offered in combination with *Asclepias curassavica*, *A. fruticosa* and *A. physocarpa*.

Of more significance, perhaps, is the observation that of these 14 eggs, none developed past the third larval instar. Also the developmental rate of these larvae was about half that of larvae reared on *A. fruticosa* and *A. curassavica* at the same time and under otherwise identical conditions. Mr D. James (pers. comm.), however, has reared larvae successfully on *A. hortorum* from the fourth larval instar.

Discussion

These three case histories from our own observations illustrate the difficulties inherent in using oviposition records as indications of food plants and, secondarily, point up the complications associated with any attempt to define the term 'food plant'. The examples can be multiplied. *Polyura pyrrhus* (L.) will lay on *Jacaranda* sp., *Euploea core* will lay eggs on frangipani leaves and Coleman (1962) records *Graphium sarpedon* L. ovipositing in large numbers on leaves of cultivated avocados. Recent observations of D. P. Sands (pers. comm.) on *E. core* indicate that this species may occasionally complete its larval life successfully on frangipani. These observations of course do not mean that the species of butterfly concerned will never feed on the plants named and the quoted references may well reflect genuine records of feeding. However we have been unable to bear them out.

The key to why the insects should make 'mistakes' in their oviposition behaviour lies in current notions of coevolution. These suggest, among other things, that two species that are in contact over a long period of time may develop finely tuned interactions to the advantage of individuals of one or other or both species. A butterfly in contact with a range of potential food plants will develop, through time, mechanisms of choice that ensure the survival of its offspring. Individuals which deposit eggs on unsuitable plants will leave less offspring than otherwise and eventually this tendency will be eliminated from the population. Alternatively the butterfly may develop biochemical or other mechanisms to overcome the defence mechanisms of the plant concerned. Both of these evolutionary mechanisms, however, take time. The insect, of course, may be able to cope fortuitously with the new contact as in the case of the Indo-Australian *E. core* and the Mediterranean *Nerium* spp. In a similar case the northern Queensland species, *Pachliopta polydorus* L., is able to use *Aristolochia elegans* in addition to the native species of *Aristolochia* (D. P. Sands, pers. comm.).

In the three case histories described above, the butterfly/plant contact is post-European settlement of Australia. The chemical and visual signals emanating from the unsuitable plant species must be sufficiently similar to those of plants that are acceptable to the butterflies due to previous coevolutionary episodes. Given sufficient time it is likely that these 'mistakes' in oviposition will be eliminated or circumvented by physiological changes in the larvae.

The *D. plexippus/Araujia hortorum* case suggests that defining a 'food plant' of a butterfly simply as a species of plant on which the larvae of the species is seen to feed, is not enough. A better but still workable definition would be "a plant on which the species can complete its immature feeding period and then successfully complete pupal/adult metamorphosis". Even this may not suit the purists as there could well be second or later generation effects due to a plant species that is only marginally unsuitable. This later extension of the problem, however, requires for its resolution substantial amounts of close observation of the species concerned which will be out of the question for all but a small proportion of species.

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PARASITISM OF THE AUSTRALIAN PLAGUE LOCUST *CHORTOICETES*
TERMINIFERA (WALKER) (ORTHOPTERA: ACRIDIDAE) BY
PRIONYX SAEVUS (SMITH) (HYMENOPTERA: SPHECIDAE)

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Abstract

The sphecid *Prionyx saevus* (Smith) is recorded parasitising the Australian plague locust, *Chortoicetes terminifera* (Walker), in western New South Wales during an outbreak in 1979. Observations on nesting behaviour are given and evidence is presented of possible migration with host swarms. The inquiline *Protomiltogramma cincta* Townsend is recorded infesting a high proportion of hosts at one *P. saevus* nesting site. Despite the conspicuous activity of *P. saevus* described, it is concluded that *P. saevus* caused an insignificant reduction of host numbers during the outbreak.

Introduction

The observations of the behaviour of *Prionyx saevus* (Smith) reported in this paper were made during the course of routine surveys of activity by the Australian plague locust, *Chortoicetes terminifera* (Walker), during the initial phase of the 1979 plague (Baker 1979). *P. saevus* was observed at fourteen localities in the Far North West and Lower Darling districts of New South Wales between January–April 1979, and at nine locations in the Central Western Plain during November–December 1979 (Fig. 1). Observations in January 1979 were of concentrated nesting activity by *P. saevus* during a period of active swarm migration by its host *C. terminifera*. This paper reports on two of these populations of *P. saevus*: Weinterriga Tank (142° 51'E, 32° 04' S) and Boolaboolka Lake (143° 07' E, 32° 36' S). Further sightings in March and April 1979 were of less conspicuous activity by individual *P. saevus* associated with low density residual populations which remained in the Far North West following mass emigration on 20th March, 1979 (Baker 1979). Sightings in the Central Western Plain in November–December 1979 were of small concentrations and individuals associated with actively migrating swarms.

P. saevus has not previously been reported as a parasite of *C. terminifera*. The yellow-winged locust, *Gastrimargus musicus* (F.) has been recorded as a host of *P. saevus* in Queensland (Common 1948). A specimen of *P. saevus* in the Australian National Insect Collection is pinned with a female *Zabrala ceripes* Sjöst. (Acrididae) (E. Evans, pers. comm.).

Female sphecids capture prey which they paralyse and bury in a ground nest; an egg is placed on the immobilised prey and after hatching the larva develops as an external parasite, killing its host (Evans 1958). Sphecids have been variously termed predators (Greathead 1963) and parasites (Rees 1973). The latter convention has been adhered to in this paper.

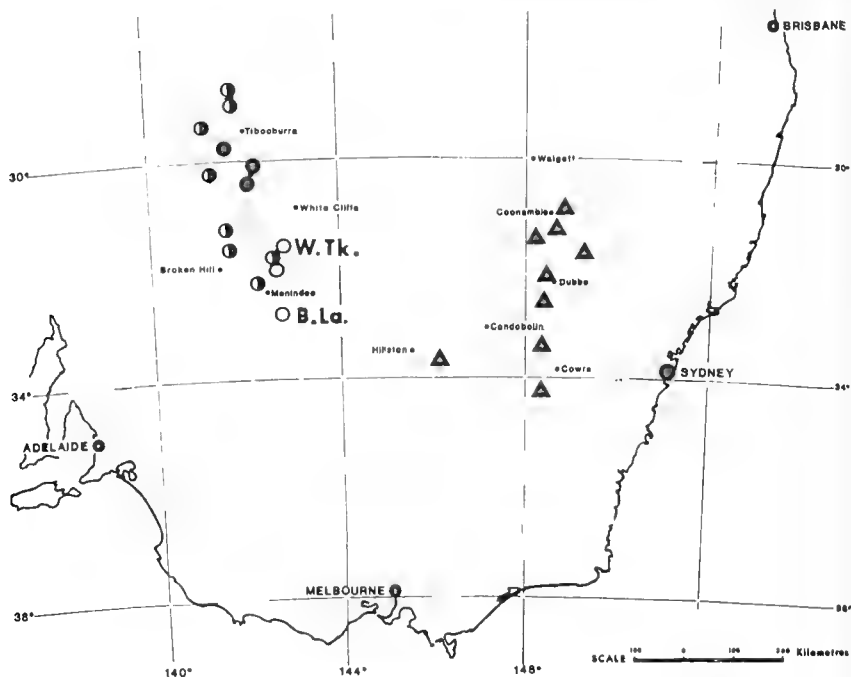


Fig. 1. Records of *Prionyx saevus* associated with *Chortoicetes terminifera* swarms during the 1979 plague: ○, 29-30th January, 1979; ◐, 1-6th March, 1979; ●, 13th April, 1979; ▲, November-December, 1979; W.tk., Weinteriga Tank; B.La, Boolaboolka Lake.

Life history of *P. saevus*

Distribution of nesting sites:

At both the Weinteriga Tank (Fig. 2) and Boolaboolka Lake sites (Fig. 3) nest of *P. saevus* were restricted to the coarse red sand used in the road's construction. Few nests were located on the outside fall of the table-drain and none in undisturbed soil (heavy grey clays) beyond the table-drain (Fig. 4).

Intense nesting activity was confined to an area of approximately 0.6 ha at both sites (40 x 150 m: Weinteriga Tank site; 40 x 120 m: Boolaboolka Lake site). At the Boolaboolka Lake site the length of the roadway over which *P. saevus* was active corresponded to the width of a low density drift of *C. terminifera*. At this site, the concentration of nesting sites appeared to be primarily dictated by the abundance of prey.

Nest density:

Nests within the nesting area at the Weinteriga Tank site were at a radial spacing of approximately 1.5 metres; sufficient to prevent overlapping of chambers. At the Boolaboolka Lake site the maximum nest density was 1: 2.76 m² (94 nests in an area of 260 m²) and the average nest density on



Figs 2-3. *Prionyx saevus* nesting sites: (2) Weinteriga Tank, 29th January, 1979, viewed towards the north-east; (3) Boolaboolka Lake, 30th January, 1979, viewed towards the north-west.

the shoulder of the road (the preferred location) was 1: 4.57 m² (225 nests in 1030 m²) (Fig. 4).

Nest construction:

Nests are of diagonal type according to the classification system of Evans (1958) and multi-chambered. The number of chambers in six nests excavated at the Weinteriga Tank site ranged from 5 to 11 (mean = 7). Chambers were located at depths ranging from 9 to 23 cm with the majority located between 10 and 13 cm (Fig. 5). Soil from the nest was always deposited on the lower slope with chambers radiating out from the entrance below the upper slope (Fig. 2). One instance of small pebbles (10-15 mm) being placed over the entrance was observed. The majority of nests had a conspicuous entrance with no evidence of any attempt at concealment (Fig. 2).

One series of observations made at the Weinteriga Tank site on 29.i.1979 between 1500-1600 hrs typifies the behaviour of a *P. saevus* female: the host was taken prior to chamber construction and concealed in a hide a short distance from the nest. The hide consisted of a large clod of clay located 2.55 m from the nest. During the construction of the chamber five brief visits were made to the hide at intervals ranging from 2-25 minutes. When chamber construction was complete (56 minutes after observations commenced) the host was transferred to a new hide: under a "paddy melon vine" 18 cm from the nest entrance (Fig. 6). The female re-entered the nest five times over a two minute period bringing minimal soil to the surface. This activity may have been to clear the tunnel rather than further expand the chamber. The host was then brought to the nest entrance and placed with its head at the nest entrance. The female then entered the nest and immediately turned and commenced to back into the nest pulling the host in head first (Fig. 7). The female re-emerged after 6.5 minutes and commenced filling by flicking soil roughly into the nest with forelegs. The nest was entered for four brief periods of 5-15 seconds over a two minute period. The female then vacated the area with no attempt having been made to conceal the nest entrance.

In observations on other females the interval between entering nest with host and the commencement of filling occupied one minute 40 seconds and two minutes 10 seconds. Filling consistently occurred over a 2-3 minute period.

Host range and oviposition:

All 77 hosts recovered from chambers were adult female *C. terminifera*. The host is placed in the chamber head-in with a lateral surface uppermost. A single egg is laid on each host. The egg is laid on the upper lateral surface with the anterior end opposed to the membranous area immediately posterior to the epimeron of the metathorax. The remainder of the egg is arched over the hind-femur (Fig. 8). Evans (1958) reports a similar placement of eggs in

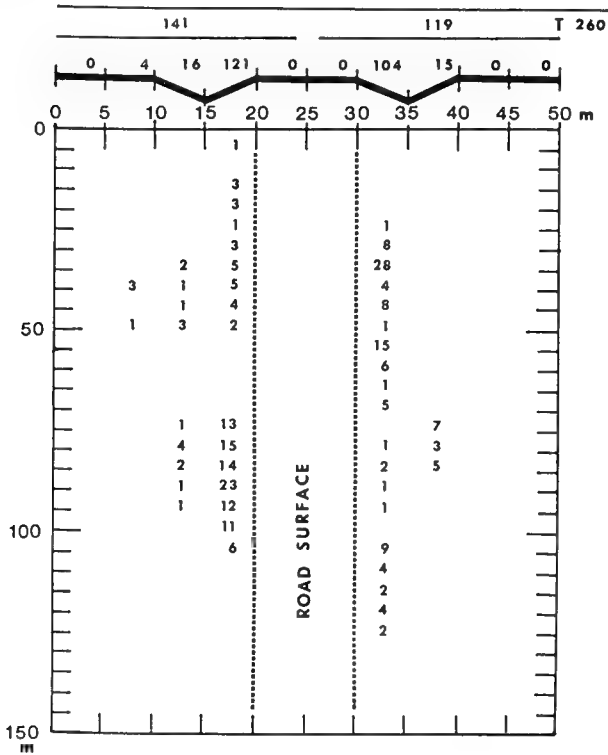


Fig. 4. Distribution of *Prionyx saevus* nests within a plot of 0.75 ha at the Boolaboolka Lake site, 30th January, 1979. Number in sub plots of 25 m² indicated.

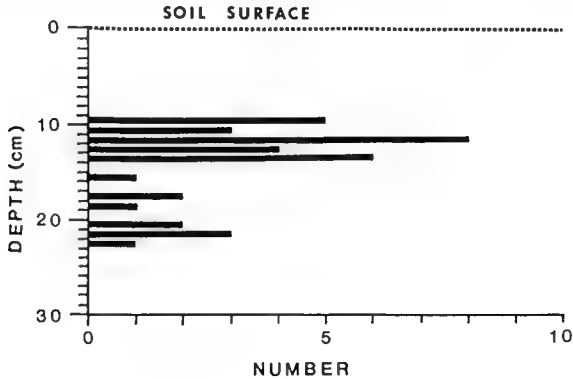
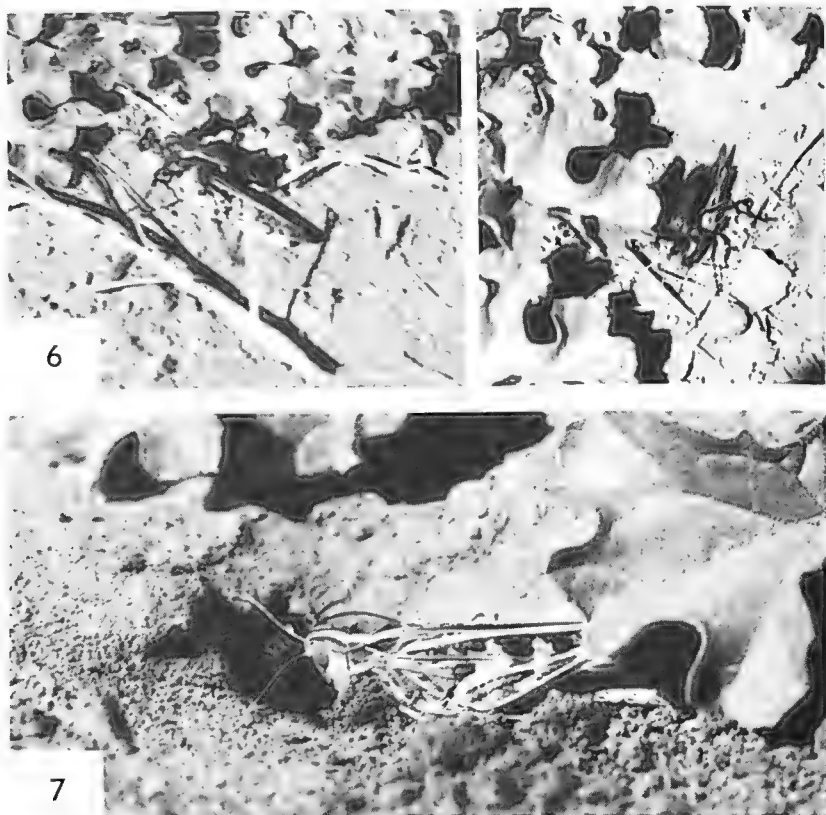


Fig. 5. Frequency distribution histogram of the depth of *Prionyx saevus* chambers in red sand at Weinteriga Tank site.



Figs 6-7. Transport of *Chortoicetes terminifera* by *Prionyx saevus*: (6) two views of female *P. saevus* straddling *C. terminifera* during transport from hide to nest. Note base of antenna grasped in mandibles and fore legs crossed under neck of host; (7) transporting host into nest.

several North American species of *Prionyx*. Frequently the paralysed locust had lost one hind leg (13 out of 42 at the Weinteriga Tank site; 11 of 35 at the Boolaboolka Lake site) and the egg was invariably deposited on that side.

Larval and pupal development:

No eggs had hatched when hosts were examined on 29-30th January, 1979. Hosts bearing eggs were collected at both sites but all eggs failed to hatch due, in part, to infestation by larvae of the inquiline, *Protomiltogramma cincta* Townsend (17 out of 19 hosts from Boolaboolka Lake site infested).

At a subsequent inspection of the nesting sites on 6th March, 1979, 19 empty *P. saevus* pupal cases were recovered from three nests at Weinteriga Tank site and one empty pupal case and one viable pupa were recovered from six *P. saevus* nests at Boolaboolka Lake site: development from egg to adult



Fig. 8. Two views of *Prionyx saevus* egg on lateral surface of pterothorax of *Chortoicetes terminifera*.

having been completed in less than the 35-36 day interval between observations. Soil temperature at a depth of 10 cm during February would approximate the mean monthly temperature of 26.3°C (Menindee; Bureau of Meteorology).

Migration of *P. saevus* with *C. terminifera*

A swarm of *C. terminifera* ($> 1000/100 \text{ m}^2$) was reported at the Weinteriga Tank site on the afternoon of 28.i.1979 together with large numbers of *P. saevus* (R. Fitzgerald, pers. comm.). When the site was inspected at 1400 h on 29.i.1979 the *C. terminifera* adults were at a density of only $10/100 \text{ m}^2$ and few *P. saevus* were present; three adults sighted between 1400-1600 h. There was ample evidence of considerable prior activity by *P. saevus* in the area. A light drift of *C. terminifera* ($\approx 500/100 \text{ m}^2$) was present at the Boolaboolka Lake site between 1000 and 1200 h on 30.i.1979. *P. saevus* was still active in the area (12 individual *P. saevus* observed in two h period), however, the large number of nests (260 in an area of 0.75 ha) would indicate intense prior activity by *P. saevus*. The apparently rapid decline in the abundance of *P. saevus* at both sites appears to have coincided with a reduction in host density following departure of the swarm from the nesting area, indicating dispersal (or migration with the departing swarm) by *P. saevus* in response to a decrease in the availability of prey. Migratory behaviour

has been reported for *Sphex aegyptius* Lep. which preys on *Schistocerca gregaria* Forskal (Haskell 1955).

Discussion

The influence of parasitism by *P. saevus* on the population dynamics of *C. terminifera* during outbreaks is slight. If the level of activity at the Boolaboolka Lake site is typical, then 2.5×10^3 hosts ha^{-1} would be taken from a possible host population of $40 \times 10^3 \text{ ha}^{-1}$ (in the *P. saevus* nesting area) or 5.2×10^6 (in the swarm) (based on typical locust densities reported in Casimir 1976). *P. saevus* was associated with only three of 43 *C. terminifera* swarms observed in the Far North West during late January 1979.

The influence of *P. saevus* on the population dynamics of *C. terminifera* may be of more importance at low host densities. In a study by Clark *et al.* (1969), densities of *C. terminifera* of less than 200 ha^{-1} were recorded in the Channel country of Queensland. At such densities, the activity of a single *P. saevus* female could significantly reduce the reproductive capacity of the population through its selective parasitism of female hosts.

Acknowledgements

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A NEW SPECIES OF *LANGIA* MOORE (LEPIDOPTERA: SPHINGIDAE) FROM NORTHERN AUSTRALIA

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Abstract

Langia tropicus sp. n. from northern Australia is described, figured and distinguished from *L. zenzeroides* Moore from the Himalayan Mountains, China, Formosa and Japan.

Introduction

The genus *Langia* was erected by Moore (1872) to accommodate *L. zenzeroides* Moore and *L. khasiana* Moore. The latter is now considered a synonym of the former. Four subspecies of *L. zenzeroides* are recognised: *L. z. zenzeroides* from the western and eastern Himalayas, *L. z. nina* Mell from south-eastern China, *L. z. formosana* Clark from Taiwan (= Formosa) and *L. z. nawai* Rothschild and Jordan from Japan. The species is also recorded from Korea but the subspecific status of the specimens is unknown (Inoue 1973).

A second species of *Langia*, similar in general appearance to *L. zenzeroides* and to date only known from tropical Australia, is described below.

The following abbreviations are used: AM Australian Museum, Sydney; ANIC Australian National Insect Collection, C.S.I.R.O., Canberra; BMNH British Museum (Natural History), London; DPP Department of Primary Production, Darwin; DPIM Department of Primary Industries, Mareeba; MSM M. S. Moulds collection.

Langia tropicus sp. n. (Figs 1-3)

Types:— *Holotype* ♂, NORTHERN TERRITORY, Koongarra, 15 km E of Mt. Cahill, 12°52'S, 132°50'E, 7.iii.1973, M. S. Upton, ANIC Registered Type No. 3314 (ANIC). *Paratypes*:— NORTHERN TERRITORY: 2 ♂, same locality as holotype, 7.iii.1973, 9.iii.1973; 1 ♀, Daly River Mission, 15.x.1974, J. F. Hutchinson (ANIC). 1 ♂, Darwin, [no date], F.P. Morris (with genitalia slide) (AM). 2 ♂, 1 ♀, Mainoru, ENE of Katherine, 22.xi.1981, A. Walford-Huggins (MSM). 1 ♂, 1 ♀, Darwin, 23.xi.1970, R. G. Byrnes (genitalia slide preparation from ♂); 1 ♂, Berrimah [near Darwin], 8.iii.1972, B. Abbey; 1 ♀, Beeboom Crossing, Daly R. on Tipperary Station, 28.xi.1972, T. Angeles & N. Forrester; 1 ♀, Daly Waters, 27.ii.1973, T. Weir & A. Allwood (DPP). 1 ♂, Mainoru, ENE of Katherine, 22.xi.1981, A. Walford-Huggins (BMNH). WESTERN AUSTRALIA: 2 ♀, Kimberly Research Station [near Kununurra], 17.xii.1952 and 30.xii.1953, R. Lukins; 1 ♀, same locality, 25.i.1957, E. C. B. Langfield (ANIC). QUEENSLAND: 1 ♀, Coen, 2.i.1922, W. McLennan (AM). 1 ♀, Station Ck. Spray, Silver Plains [E of Coen], 5.i.1959, J. L. Wassell; 1 ♀, Silver Plains Homestead, 22.ii.1962, J. L. Wassell; 1 ♂, Chillagoe, [no date or collector] (ANIC). 1 ♀, Holroyd River, S of Coen, 29.xi.1974, M. Walford-Huggins (MSM). 1 ♀, Roth Ck, via Georgetown, 8.i.1980, R. I. Storey (DPIM).

Range:— Kununurra in far north-eastern Western Australia, across the northern third of Northern Territory and in northern Queensland from near Georgetown, Chillagoe Caves and the Coen district.

MALE (Fig. 2)

Grey and reddish brown with a complex of black or blackish brown markings giving the appearance of dead or burnt wood.

Head. Densely covered by long brown scales; antennae pale orange-brown; labial palpi brown.

Thorax. Densely pilose; above brown anterior to wings; majority of area between wings light grey but boldly bordered along anterior and posterior margins by dark brown; beneath brown of similar tone, or nearly so, to that above anterior to wings.

Legs. Velvet blackish brown. Coxae densely brown pilose, femur with a ridge short brown pilose.

Wings. Fore wing with a characteristic scalloped termen, the scalloped recesses usually deepest between veins R_{3+4} and R_5 , M_1 and M_2 , M_2 and M_3 , and M_3 and CuA_1 , the termen indents again before CuA_2 and thereafter remains almost straight to tornus. Hind wing with termen only gently scalloped, or in some specimens not at all; tornal angle pointed and prominent.

Colour of fore and hind wings grey to reddish brown with black or blackish brown markings variable in both tone and clarity.

Fore wing above with termen edged black, the edging produced to form a small triangular-shaped marking near apex between R_{3+4} and R_5 ; apical and subapical area pale; subterminal area blackish grey with veins usually reddish brown and often with inner edge marked darker; remainder of wing grey to brownish grey with dark markings; a black or dark brown zig-zag shaped postmedian band, sometimes broken and indistinct; a median black band gently curved towards wing base near inner margin, indistinct and broken in costal half, distinct and usually broad towards inner margin; between this broad marking and wing base two pairs of parallel black lines usually distinct at inner margin but fading towards costa at about midway; black lines also on distal side of the median band, usually very indistinct.

Fore wing below with a dark zig-zag subterminal line similar to the postmedian zig-zag line above, this marking on the underside usually distinct for its entire length although, on some specimens, it can be indistinct or almost absent; between this zig-zag marking and termen the wing ground colour is darkest and similarly marked to upper side, the remainder paling as it approaches the base; a dark median straight band usually present although mostly indistinct; a similar postmedian band also usually present but less distinct.

Hind wing above reddish brown to grey; termen narrowly edged black; a black subterminal band distinct at tornus but fading usually about mid way between tornus and apex; often with a similar, but usually less distinct, band parallel and near to subterminal band on its basal side; remnants of a postmedian band are sometimes visible; a median band nearly always

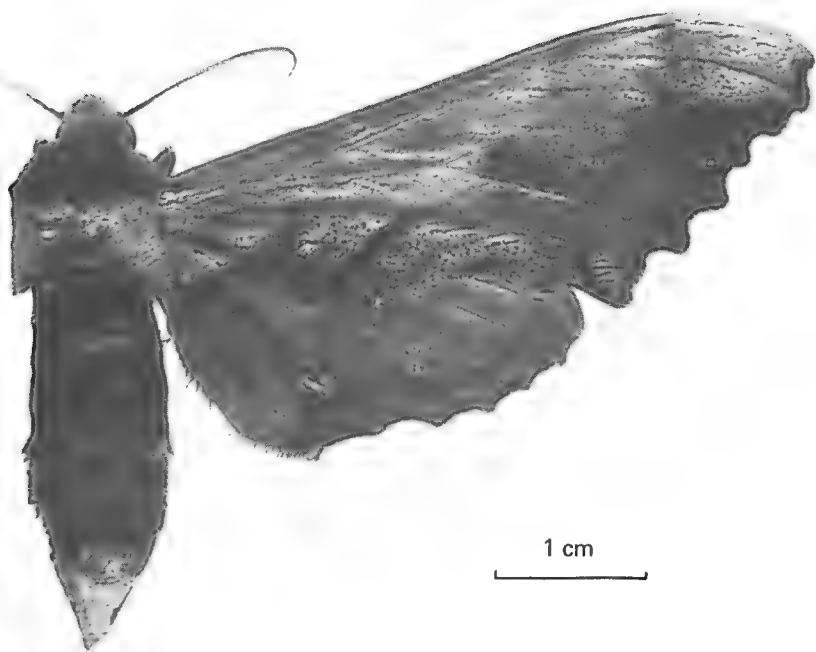


Fig. 1. *Langia tropicus* sp. n., female upperside, paratype, Station Ck. Spray, Silver Plains, Cape York Peninsular, Queensland.

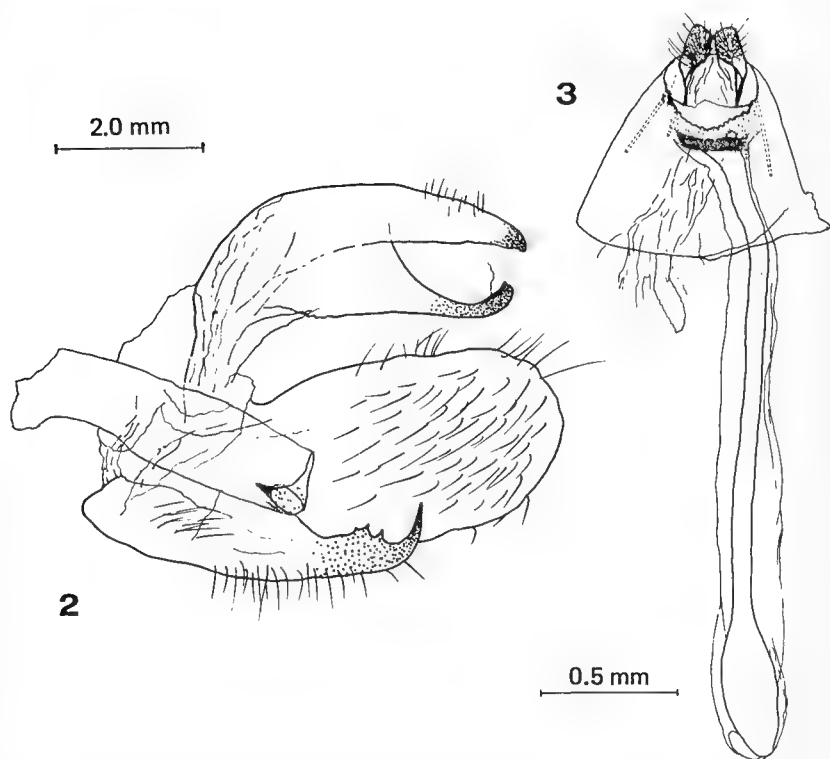
present, usually distinct but with edges not sharply defined; usually with a black area near inner margin extending from median band almost to base, this marking not sharply defined.

Hind wing below pale, finely speckled black; termen and inner margin narrowly edged black, this edging clearest from tornus to about CuA_1 ; an irregular zig-zag subterminal line, usually distinct; a postmedian line sometimes visible; a median band usually present but often broken and indistinct, this and the postmedian band fading between $1A + 2A$ and inner margin.

Length of male fore wing: 34-43 mm; mean 39.5 mm ($n=7$).

Abdomen. Above with anterior two fifths or so black or dark brown, remainder grey and usually with a broken, black midline; beneath mostly black or dark brown; usually densely brown pilose at base and posterior margin of each tergite bearing brown cilia.

Male genitalia (Fig. 2). Uncus and gnathos of almost equal length, both heavily sclerotised at apex; uncus slightly bifurcate in dorsal view; gnathos in lateral view upcurved and with a small offset pointed apex. Valva broad, oval. Harpe heavily sclerotised around apex; terminating in a long, upward-



Figs 2, 3. *Langia tropicus* sp. n., genitalia: (2) male, lateral view with left valva removed, paratype, Darwin, N.T.; (3) female, Daly Waters, N.T.

pointing spine preceded by usually two (sometimes none, one or three) short, upward-pointing spines. Aedeagus short, straight, apically with a small, stout, sclerotised spine.

FEMALE (Figs 1, 3)

Similar to male but usually larger. Wings with tornus less pointed; ground colour paler and markings in general not as well developed.

Length of fore wing: 40-52 mm; mean 46.0 mm (n=10).

Female genitalia (Fig. 3). Ductus bursae long, robust; corpus bursae simple, only slightly greater in diameter than ductus bursae; signum absent.

Comments

L. tropicus sp. n. is readily distinguished from the Oriental *L. zenzeroides* by the clearly marked light and dark lunules in the crenulations along the termen on the upperside of the fore wing on *L. zenzeroides*, such markings being absent on *L. tropicus*; the fore wing crenulation adjoining tornus is deep

and similar to others of fore wing on *L. zenzeroides* but on *L. tropicus* this crenulation is very shallow; the thorax above between the wings is all grey on *L. tropicus* while on *L. zenzeroides* there is a bold, dark, curved marking along either side of the thorax adjoining the wings; and specimens of *L. zenzeroides* are nearly always larger than the largest individuals of *L. tropicus*.

The male genitalia of *L. tropicus* and *L. zenzeroides* are markedly different. The valva of *L. tropicus* is broadly oval but that of *L. zenzeroides* is long, gently curved upwards and narrowing towards a bluntly pointed apex; the harpe of *L. tropicus* terminates in a long spine but that of *L. zenzeroides* forms a long, horizontal, ventral process lobate at apex; and the uncus of *L. tropicus* is only slightly bifurcate but that of *L. zenzeroides* is deeply so while the gnathos of *L. tropicus* is a single structure but paired on *L. zenzeroides*. Male genitalia of *L. zenzeroides* are figured by Bell and Scott (1937: text-fig. 43, these figures being direct copies from Rothschild and Jordan); Mell (1922, pl. XXXV, fig. 11) and Rothschild and Jordan (1903: pl. XXIV, figs 25, 26; pl. XXX, fig. 48; pl. XXXIII, figs 14, 15).

Female genitalia of the two species could also be very different but details concerning that of *L. zenzeroides* were unavailable.

The early stages of *L. tropicus* are unknown. Larvae of *L. zenzeroides* feed on apple, pear, cherry, apricot, Japanese apricot and medlar (all family Rosaceae) (Bell and Scott 1937, Mell 1922). Detailed descriptions of the life history of *L. zenzeroides* are also provided by Bell and Scott, and Mell.

Acknowledgements

I wish to thank Allan and Maria Walford-Huggins for donation of specimens and the Curators of the Australian Museum, Sydney, Australian National Insect Collection, Canberra, Department of Primary Production, Darwin and Department of Primary Industries, Mareeba, who kindly loaned specimens. Provision of research facilities by the Trustees of the Australian Museum is gratefully acknowledged. Mr E. D. Edwards and Dr C. N. Smithers kindly offered helpful comments on the manuscript.

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COVER

Illustrated by Stephen Underwood

The Bentwing Swift Moth, *Zelotypia stacyi* Scott (family Hepialidae) is one of Australia's largest moths with species often having a wing span in excess of 230 mm. Adults are tawny brown with silver-white markings and the spectacular raised eye spot gives the fore wing the appearance of a reptilian head. The larvae feed on only a few species of eucalypt including the Sydney blue gum, *E. saligna*, and grow to some 130 mm over a period of 5-6 years. The species occurs in south-eastern Queensland and eastern New South Wales. It is now exceedingly rare in New South Wales.

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THE EARLY STAGES OF *PHILIRIS FULGENS KURANDAE* WATERHOUSE AND *PHILIRIS DIANA PAPUANA* WIND AND CLENCH (LEPIDOPTERA: LYCAENIDAE)

By G. A. Wood

P.O. Box 122, Atherton, N. Qld 4883

Abstract

The early stages of *Philiris fulgens kurandae* and *Philiris diana papuana* are described. The food plant of both species is *Litsea leefeana* (F. Muell.) Merr. (fam. Lauraceae).

Introduction

While examining leaves of *Litsea leefeana* (F. Muell.) Merr. (Lauraceae) at Iron Range, Queensland, in September 1982 several lycaenid ova and larvae were found. These were well camouflaged in skeletonized patches beneath the leaves. When reared the larvae were found to belong to different species *Philiris fulgens kurandae* Waterhouse and *Philiris diana papuana* Wind and Clench. The life history of both species has previously been unrecorded (Common and Waterhouse 1981).

Philiris fulgens kurandae Waterhouse

Egg. Domed, white, densely pitted and spined, 0.6 mm diameter.

First instar. Densely haired, pale yellow, 1.6 mm long.

Second instar. Green with a brown median dorsal line surrounding an inner broken yellow line. Prothoracic plate with an interrupted, pale brown, dorsolateral arc. Spiracles white. Hair restricted to a dense lateral fringe. Length 3 mm.

Third instar. Similar to second instar but markings slightly less distinct. Length 5 mm.

Fourth instar. Green, except for an orange dorsal line and faint orange mottles at segment edges. Hair restricted to a dense lateral fringe. Length 9 mm.



Figs 1-4. (1) 5th instar larva and (2) pupa of *P. fulgens kurandae*; (3) 5th instar larva and (4) pupa of *P. diana pupa papuana*.

Fifth instar. (Fig. 1). Similar to fourth instar but markings less distinct. Length 13 mm.

Duration of larval stage approximately 40 days.

Pupa (Fig. 2). Pale green with scattered orange mottles. Thoracic midline brown, terminating in a patch of brown mottles on mesothorax. Abdominal segments with a brown dorsal line, meeting the brown marginal metathorax. Spiracles dark brown. The pupa is attached to a silken pad on the underside of a leaf of the food plant by anal hooks and central girdle. Length 9 mm.

Pupal duration 9 to 11 days.

Philiris diana papuana Wind and Clench

Egg. Domed, white, densely pitted and spined, 0.6 mm diameter.

First instar. Densely haired, pale yellow, 1.6 mm long.

Second instar. Finely haired. Orange, with a distinctly coloured dorsal region consisting of a yellow line terminating in two purple areas, the anterior being the larger, all these markings surrounded by a narrow green margin. Viewed dorsally, prothoracic plate with an arc of purple and remaining segments with a small purple area at anterior corners. Spiracles white. Length 4 mm.

Third instar. As in second instar but markings less distinct and lacking the purple areas on segment corners. Length 7 mm.

Fourth instar. As in third instar except colours less distinct. Length 11 mm.

Fifth instar (Fig. 3). Orange, dorsal region green with two rows of yellow mottles. Lateral hairs longest, and forming a fringe around the body. Length 17 mm.

Duration of larval stage approximately 45 days.

Pupa (Fig. 4). Covered with small bristle-like projections. Brown and cream in colour. Wing cases with brown and cream longitudinal stripes. Median dorsal line brown, bifurcate after the mesothorax and following the wing margins, dorsal midline of abdominal segments pale brown. Attached to a silken pad on the upperside of a leaf of the food plant, by anal hooks and central girdle. Length 13 mm.

Pupal duration 11 to 13 days.

Acknowledgement

I wish to thank B. P. M. Hyland, Division of Forest Research, C.S.I.R.O., Atherton, for identifying the food plant.

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A NOTE ON *HESPERILLA CHAOSTOLA LEUCOPHAEA* COUCHMAN
(LEPIDOPTERA: HESPERIIDAE)

By R. G. Douglas

P.O. Box 140, Kingston, Tasmania, 7150

Abstract

The rare and endangered Australian skipper butterfly *Hesperilla chaostola leucophaea* is rediscovered in south-eastern Tasmania and a new locality record given.

Common and Waterhouse (1981) note that the skipper *Hesperilla chaostola leucophaea* Couchman is rare and very local in Tasmania. Colonies of the insect have previously been located on Mount Knocklofty in Hobart and in Kingston to the south of the city. Solitary records also exist for Huonville (in 1902) and Bicheno (in 1945). As a result of housing development in the two colony areas Couchman and Couchman (1978) list the insect as an endangered species with no recent record of collection.

Searching of Mount Knocklofty has not revealed the existence of a colony there in recent years. Housing and fire may have eliminated it.

However despite the urban settlement in the Kingston area, this author is able to report the continued existence of the skipper in this type locality. In the three years 1980, 1981 and 1982 the insect has been taken. While the foodplant is relatively abundant, *Hesperilla chaostola leucophaea* does not occur in any numbers. Unfortunately the colony's future is threatened. At November 1982 a further housing subdivision was being made into the area occupied by the insect. It must still be considered rare and the future of the Kingston colony exceedingly tenuous.

Couchman and Couchman (1978) suggested that the insect may occur in the Channel area in a habitat similar to that at Kingston, a sandy hillside with a northerly aspect. This suggestion has been confirmed with the location by this author of a colony of the insect on The Sheppards Hill at Coningham, an area approximately 12 km south of the type locality. Specimens have been taken in 1981 and 1982 in the area. At present this colony is not threatened by housing development, but is in an area which frequently suffers bushfire.

Acknowledgement

I wish to thank L. E. and R. Couchman for their continued interest and encouragement in the study of this butterfly.

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INSECTS ASSOCIATED WITH *ALOCASIA MACRORRHIZA* (L.) G. DON (ARACEAE) IN QUEENSLAND

By B. K. Cantrell

Entomology Branch, Department of Primary Industries, Indooroopilly, Qld 4068

Abstract

Insects recorded feeding or resting on *Alocasia macrorrhiza* (L.) G. Don are listed, and life history data provided where available.

Introduction

During a study of the pollination of *Alocasia macrorrhiza* (L.) G. Don ("cunjevoi" or "spoon lily") in Queensland from October 1981 to February 1982, all insects observed to be associated with this plant were recorded, but particularly those present on the inflorescences.

The stands of *A. macrorrhiza* observed in south-eastern Queensland were on private property adjacent to large reserves of rainforest at Mt Glorious, Mt Nebo and Mt Tamborine, ca 650 m, 520 m and 500 m above sea level respectively and in simulated rainforest recently established at Mt Coot-tha Botanic Gardens and the University of Queensland in Brisbane. At all sites plants occurred in scattered clumps, often in or near small streams. In addition, some mature seed heads from Tolga, northern Queensland, growing in an area of remnant rainforest were examined.

Representative specimens of all species are lodged in the Entomology Branch, Department of Primary Industries, Queensland (QDPI).

Insects encountered

Insects on inflorescences

Insects recorded within the open spathe chamber containing the female flowers and later on the spadix after closure of the spathe chamber have been reported by Hamilton (1898), McAlpine (1978), Shaw *et al.* (1982) and Shaw and Cantrell (1983).

Insects within mature seed heads

Insects recorded within sealed spathe chambers at maturity have been reported by McAlpine (1978), Shaw *et al.* (1982) and Shaw and Cantrell (1983). Some mature heads from Tolga contained the aphid *Pentalonia nigronervosa* f. *caladii* van der Goot; this insect has previously been recorded from *Alocasia* by Eastop (1966), but he does not state on which species or which part of the plant aphids were found.

Insects feeding on A. macrorrhiza

All species observed feeding on *A. macrorrhiza* during some part of their life cycle are listed in Table 1.

Insects resting on A. macrorrhiza

A large number of insects are known to use the leaves of this plant as resting sites and some have been listed by McAlpine (1978); others recorded in this study are shown in Table 2.

Life history information

Since most of the collections of species feeding on cunjevoi were immature stages, requiring rearing to adults for identification, some life history data became available and is presented below. Rearing was done in the laboratory at ca 25°C.

Cruria donovani (Boisduval) larvae were usually found inside "buds" at rainforest sites, gaining entry by chewing a hole near the base of the spathe chamber and feeding on the developing ovaries and spadix. On other occasions larvae were feeding on unfurled leaves so that when these leaves opened they presented a tattered appearance and/or collapsed due to weakening of the leaf stalk. Larvae are yellow to orange with transverse rows of roughly circular black spots bearing long pale hairs on each segment, and a black head capsule. Mature larvae may reach 4.0 cm and presumably leave the plant to pupate in the soil since reared larvae constructed loose cells in wood shavings provided for this purpose. The duration of the pupal period was 17-20 days (mean 19). The adult moth has a wingspan of 4.5-5.5 cm, and is mainly black with small patches of yellow on the forewing and a broad yellow band on the hindwing. The abdomen is banded black and yellow with an orange tip. McAlpine (1981) lists additional hosts.

Spodoptera litura (F.) larvae were collected on two occasions only, both at the University of Queensland feeding on leaf blades. These pupated in the soil, but only one survived, lasting 10 days in this stage. The larva and adult have been figured by Goodyer (1978). Later R. E. Teakle (pers. comm.) reared two adults from *A. macrorrhiza* in a garden at Moggill, near Brisbane. *S. litura* is known to have a wide host range and is probably only an occasional feeder on *A. macrorrhiza*.

Theretra tryoni Miskin was present at all sites visited and in my garden at suburban Yeerongpilly. In addition, unpublished QDPI records list feeding observations at Brisbane and Kenilworth. Larvae normally rest by day head downwards near the base of the plant in a sheathing leaf base, climbing up at night to feed. Typical of many sphingid larvae, this species has paired eye-spots on abdominal segments 1 and 2 and a caudal horn. Two light lines run along the body dorso-laterally, converging near the horn. Larvae occurred in two distinct colour forms, pale green and brown, a fact previously noted by Moulds (1981). As the larvae may reach 9-10 cm at maturity they can cause severe damage to leaves before pupating in the soil. Pupae are mottled brown with the proboscis closely adhering, and average 5.5 cm in length, terminating in two fine spines. Duration of the pupal period was 15-20 days (mean 17). Adults are drab brown with a wingspan of about 7.0 cm. Two parasites were recorded in larvae from Brisbane, both tachinid flies: *Blepharipa* sp. and *Carcelia* (*Senometopia*) sp.

Pachycolpura sp. adults and nymphs were commonly seen feeding together on leaf stalks at all rainforest sites, but appeared to cause negligible damage to the plant. No rearing of nymphs was made.

TABLE 1
Insects recorded feeding on *A. macrorrhiza*

Order	Family	Genus & species	Life stage	Locality*
Lepidoptera	Agaristidae	<i>Cruria donovani</i>	larva	G, N, T
	Noctuidae	<i>Spodoptera litura</i>	larva	B
	Sphingidae	<i>Theretra tryoni</i>	larva	B, G, N, T
Hemiptera	Coreidae	<i>Pachycolpura</i> sp.	nymph, adult	G, N, T
	Ricaniidae	<i>Scolypopa australis</i>	nymph, adult	T

* B, Brisbane; G, Mt Glorious; N, Mt Nebo; T, Mt Tamborine

TABLE 2
Insects⁺ recorded resting on *A. macrorrhiza*

Order	Family	Genus & species	Position on plant	Locality*
Orthoptera	Gryllacrididae	<i>Hadrogryllacris</i> sp.	leaf base	B
	Blattidae	<i>Rhabdoblatta</i> sp.	leaf base	T
	Tettigoniidae	<i>Salomona</i> sp.	leaf base	G, N, T
Hemiptera	Issidae	Undetermined	leaf blade	G
Coleoptera	Chrysomelidae	<i>Aproidea balyi</i> Pascoe	leaf blade	B
	Buprestidae	Undetermined	leaf blade	B
	Elateridae	Undetermined	leaf blade	G
Diptera	Ceratopogonidae	Undetermined	leaf base	T
	Stratiomyidae	<i>Acanthasargus flavipes</i> Hardy	leaf blade	B
		<i>Sciapus</i> sp.	leaf blade	G, N
	Chloropidae	Undetermined	leaf blade	N
	Muscidae	<i>Musca vetustissima</i> Walker	leaf blade	B
	Sarcophagidae	<i>Tricholioproctia</i> sp.	leaf blade	B
	Tachinidae	<i>Carcelia (Euryclea)</i> sp.	leaf blade	G
		<i>Palexorista</i> sp.	leaf blade	B
		<i>Trigonospila</i> sp.	leaf blade	B
		<i>Sumpigaster</i> sp.	leaf blade	B
		<i>Zosteromeigenia mima</i> Townsend	leaf blade	N

+ All adults except some immatures of *Salomona* sp. and Ceratopogonidae

* B, Brisbane; G, Mt Glorious; N, Mt Nebo; T, Mt Tamborine

Scolypopa australis (Walker) was only recorded at Mt Tamborine. Nymphs were noted first (12.xii.1981), with the first adults appearing two weeks later (27.xii.1981). Nymphs are mottled brown and white with a fan of waxy abdominal filaments held over the body giving a "seed-like" appearance. Fletcher (1979) described all life stages. Like *Pachycolpura* sp. they did not appear to cause any damage.

Little information is available for insects using the plant as a resting site. The Orthoptera are all nocturnal and were found resting by day concealed

well down in sheathing leaf bases. *Salomona* sp. (No. 3 in the Australian National Insect Collection, CSIRO, Canberra) is known to occur from Cooktown in Queensland to Bateman's Bay in New South Wales; near its southern limit it is found in a similar situation in *Crinum* (Amaryllidaceae) (D. C. F. Rentz, pers. comm.). The sheathing leaf bases are sometimes water filled and larvae of Ceratopogonidae were found in them on a number of occasions at Mt Tamborine. Dolichopodid flies (*Sciapus* sp.) were observed on several leaves at both Mt Glorious and Mt Nebo on the same day (20.xii.1981), with up to twenty flies resting on a leaf and engaging in apparent "mating chases", running rapidly over the leaf in pursuit of one another and making short flights above the leaf before alighting to continue the sequence. The flies were very difficult to capture, but the small sample obtained contained both sexes, and although no actual matings were observed, this appears to be the best explanation for this behaviour. At the time, leaves were in bright morning sunshine.

Acknowledgements

I thank Dr D. E. Shaw for stimulating my interest in *A. macrorrhiza* and arranging with the Rev. R. D. Collins to provide material from Tolga. The owners of the sites sampled, Mr A. Hiller, Mr A. L. Marstella and Mr W. Scattini are thanked for their co-operation. I am also grateful to Mr H. Caulfield (Mt Coot-tha Botanic Gardens) and Dr A. B. Cribb (University of Queensland) for permission to use those reserves. Mr K. J. Houston and Dr D. C. F. Rentz provided insect identifications.

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FIRST RECORD OF *PHILIRIS AZULA* WIND AND CLENCH (LEPIDOPTERA: LYCAENIDAE) FROM AUSTRALIA

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Abstract

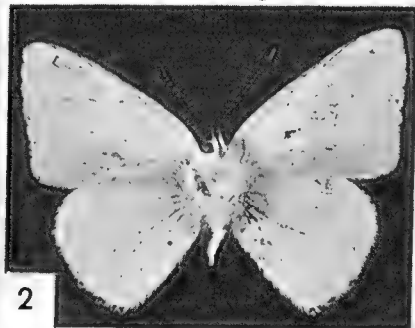
A specimen of *Philiris azula* Wind and Clench was collected for the first time in Australia at Iron Range, Cape York Peninsula, northern Queensland.

During a trip to Iron Range, Cape York Peninsula, in June and July 1981 a single male of a *Philiris* species (Figs 1, 2) was taken which appeared different from other species of *Philiris* known to occur in Australia. It has been identified as *Philiris azula* Wind and Clench by comparison with males from Papua New Guinea and examination of the genitalia (Figs 3-6).

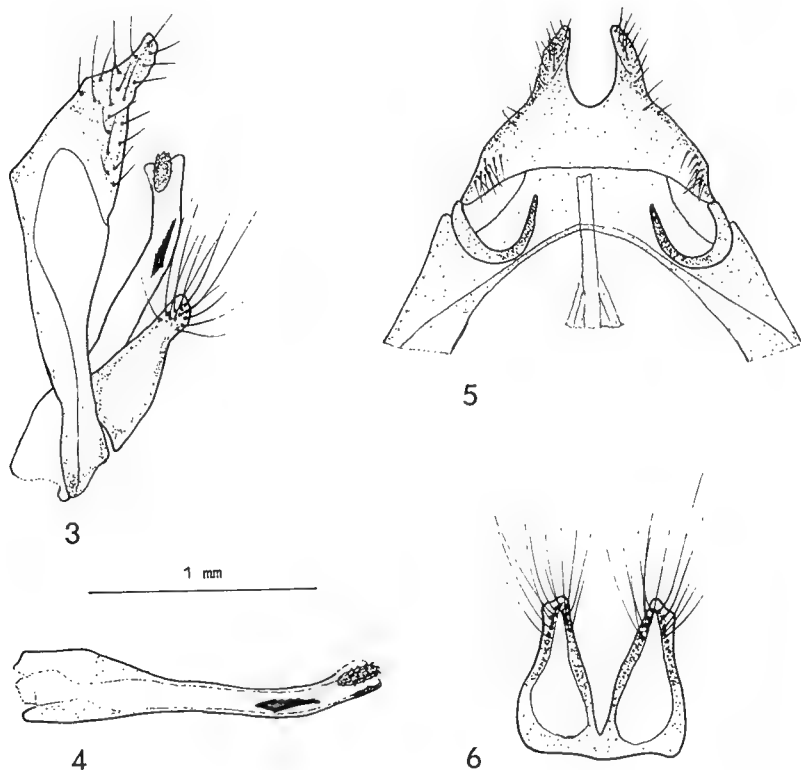
The specimen was taken flying around the top of a rainforest tree about 12 m in height, in company with males of *P. fulgens kurandae* Waterhouse, *P. ziska titeus* D'Abrera and *Ionolyce helicon hyllus* (Waterhouse and Lyell). Label data for the specimen reads as follows: Iron Range, 10.vii. 1981, I. R. Johnson (in S. J. Johnson collection).

There are few published records of *Philiris azula* other than of the original specimens from near Wau in Papua New Guinea (Wind and Clench, 1947), and the species has not been illustrated except for the male genitalia which are figured in Tite, (1963). More recently it has been taken throughout lowland areas of mainland New Guinea (D. P. A. Sands, pers. comm.).

The apices of the fore wings of the Australian specimen are more broadly black, than in specimens from New Guinea. Males of *P. azula* (Figs 1, 2) can be distinguished from those of other *Philiris* species known to occur in Australia by the shining, light blue colour of the upper side of the fore and hind wings and by the reduced dark margins of the hind wings.



Figs 1, 2. *Philiris azula* Wind and Clench: (1) male from Iron Range, northern Queensland, upperside; (2) the same, underside. Figured twice natural size.



Figs 3-6. *Philiris azula* Wind and Clench, genitalia of male from Iron Range, northern Queensland: (3) genitalia unmounted, lateral view; (4) aedeagus; (5) sociuncus; (6) valvae from slide preparation.

Acknowledgements

We wish to thank Mr D. P. A. Sands for confirmation of the identification and Mr R. J. Parker for preparation of the photographs.

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FROGGATT'S ACCESSION NOTEBOOKS

By P. J. Gullan

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Walter Wilson Froggatt was Government Entomologist at the Department of Agriculture in New South Wales from 1896 until his retirement in 1923, after which he was Special Forest Entomologist to the Forestry Commission of New South Wales until 1927 (Sussmilch 1937). He published more articles on Australian insects than any other entomologist (Musgrave 1932) and amassed large collections of insects. Froggatt labelled his specimens (Coccoidea, other Hemiptera, Thysanoptera, Coleoptera, and other groups) with accession numbers. Frequently no other data, except the species name, appear on the specimen labels. For this reason, the accession notebooks in which Froggatt recorded collection data are of immense scientific importance.

When I began research on Froggatt's coccoid collection, the whereabouts of Froggatt's accession notebooks was uncertain. During a visit to the taxonomic section of the Biological and Chemical Research Institute of the New South Wales Department of Agriculture at Rydalmere, the first of Froggatt's notebooks was located in a cupboard in the collection room. This book lists accession numbers one to 1091, which cover the period from about 1890 to 1923, the year of his retirement from the Department.

It is possible that Froggatt began a second notebook containing accession numbers greater than 1091 in 1923/24, after his appointment to the Forestry Commission of New South Wales. If he did, its present whereabouts is unknown and the Forestry Commission of New South Wales has been unable to locate any such book (P. Hadlington pers. comm.).

Recently, however, a notebook, completed in 1932 with number 2713, was found at the Biological and Chemical Research Institute at Rydalmere. It commences with a "list of Australian coccids from old lists to Green and Maskell" and lists (without collection dates) many of the earlier numbers recorded in the first book, sometimes with more detailed collection data or with different identifications. In some instances, data for particular accession numbers differ between the notebooks. The first half of this more recent notebook records some new numbers (greater than 1091), but these start with number 1500 and lack collection dates until number 1629 (August 12, 1926). Presumably this was the date when Froggatt began to record fully his recent accessions in this notebook.

Numbers 1092 to 1499 may never have been allocated; certainly there do not appear to be specimens bearing such numbers in the Australian National Insect Collection in Canberra, although there are specimens with numbers just greater than 1500 collected in 1923, the year the first accession notebook was completed.

It is not known whether Froggatt kept records past 1932; he died on March 18, 1937.

Copies of the two notebooks are now lodged with the Australian National Insect Collection in Canberra.

Acknowledgements

I wish to thank Dr E. Schicha and Mr G. Brown, B.C.R.I., Department of Agriculture, N.S.W., Mr P. Hadlington, Forestry Commission of N.S.W., and Mr M. S. Upton, C.S.I.R.O., Division of Entomology, Canberra, A.C.T., for their assistance with information on Froggatt's records. Murray Upton also commented on the manuscript.

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A NEW NORTHERN RECORD FOR THE COMMON SILVER XENICA, *OREIXENICA LATHONIELLA* (WESTWOOD) (LEPIDOPTERA: NYMPHALIDAE)

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Abstract

The known distribution of *Oreixenica lathoniella herceus* Waterhouse and Lyell is extended northwards to near Bald Rock, approximately 25 km north of Tenterfield, New South Wales.

Introduction

Oreixenica lathoniella herceus Waterhouse and Lyell is the northernmost race of this butterfly. It is recorded as occurring south from Dorrigo on the tablelands of New South Wales to south-western Victoria; two further subspecies are found in Tasmania (Common and Waterhouse 1981).

Observations

On 18th April 1982 a small colony of *Oreixenica lathoniella herceus* was discovered in an insignificant swamp 2 km east of Bald Rock (about 25 km north of Tenterfield) at an elevation of some 1200 m. This locality is about 160 km north of its previously known northern limit, Dorrigo.

Mr E. D. Edwards has kindly examined my specimens and informs me that they "have rather more extensive brown areas and narrower black areas than . . . specimens from the Ebor-Point Lookout area near Dorrigo".

Two specimens have been lodged with the Australian National Insect Collection, while I have retained one other.

Acknowledgement

I wish to thank Mr E. D. Edwards of the C.S.I.R.O. for confirming the identity of the species and for supplying comparative descriptive information on it.

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NEW AND LITTLE KNOWN STONEFLIES (PLECOPTERA: GRIPOPTERYGIDAE) FROM QUEENSLAND AND VICTORIA

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Abstract

The adults of five new species and the hitherto unknown female of *Kirrama abolos* Theischinger are described. The new taxa are: *Dinotoperla hybrida* (♂, ♀), *Leptoperla alata* (♂, ♀), *L. dahmsi* (♂, ♀) and *L. rotunda* (♂, ♀) from Queensland and *Leptoperla rubiconis* (♂) from Victoria.

Introduction

Examination of the stonefly collections of the Australian National Insect Collection (ANIC), the National Museum of Victoria (NMV), the Queensland Museum (QM) and the University of Queensland (UQ) led to the discovery of five unnamed species and the hitherto unknown female of a recently defined genus (Theischinger 1981). The adults of these are described below, the nymphs remain unknown.

Code numbers in parenthesis appearing with holotype designations are Queensland Museum type numbers.

Dinotoperla hybrida, sp.n.

(Figs 1-4)

Types. QUEENSLAND: Holotype ♂ (T.8594) and 8 paratypes (3 ♂, 5 ♀), Bellenden Ker Range, Cable Tower 3, 1054 m, 25-31.x.1981, 5 paratype ♂, Mt Bartle Frère, 0.5 km N. of South Peak, 1500 m, 6-8.xi.1981, and 2 paratypes (1 ♂, 1 ♀) Bellenden Ker Range, Summit TV Stn, 1560 m, 1-7.xi.1981, all EARTHWATCH/QM (QM).

Colour pattern and wing venation as presented in general description for *Dinotoperla* by Theischinger (1982). Basic colour of head, thorax and legs yellowish grey to greyish brown. Wings slightly suffused with brownish grey all over, heavily tinted narrowly along the rather light distal crossveins of forewing. Abdomen whitish yellow, at least part of all tergites and sternites heavily sclerotized and darkened (black) in male, only segments VIII-X sclerotized variably and slightly darkened in female. Male genitalia (Figs 1-3): Central sclerite of tergite X narrowly sclerotized at base and produced posteriorly into a long pointed membranous cone. Epiproct slender, hook-like, with shorter pointed subapical and longer pointed apical ventral spur, a single pair of dorsal spines close to base. Paraprocts with narrow base, bowed dorsad, apex simply and slightly pointed. Cerci generally 12 segmented. Female genitalia (Fig. 4): Subgenital plate a wide lobe. Sternite IX with black M-shaped pattern of sclerotization. Posterior margin of tergite X rounded. Cerci with 11-13 segments.

Measurements: Body ♂ 7.0-7.8 mm, ♀ 8.5-9.5 mm; forewing ♂ 7.0-8.2 mm, ♀ 8.0-9.5 mm; antennae ♂ 6.0-8.2 mm, ♀ 7.5-8.5 mm.

Diagnostic characters are the single pair of spines on the epiproct and the simple apex of the paraprocts in male. *D. schneiderae* Theischinger and *D. spinosa* Theischinger, both from Queensland, appear close allies.

Kirrama abolos Theischinger

(Fig. 5)

Material examined. QUEENSLAND: 1 ♀, Kirrama State Forest, via Cardwell, 17-18.viii.1966, G. Monteith (UQ); 1 ♀, Mt Finnigan, 850-1100 m, 37 km S. Cooktown, 19-22.iv.1982, Monteith, Yeates and Cook (QM).

Both specimens, the first one coming from the type locality of *K. abolos*, correspond with the description given from the male (Theischinger 1981) in details of coloration of head, thorax and legs and in wing venation. Abdominal segments I-VII not sclerotized, pale yellow. Female genitalia (Fig. 5): Subgenital plate very wide and long, very slightly bilobed, sclerotized all over, yellowish to blackish brown. Sides of tergites VIII and IX sclerotized, yellowish brown. Paraprocts long, narrow, straight to slightly convergent. Tergite X brownish yellow, strongly produced posteriorly, with narrow but well rounded apex.

Measurements: Body 5.5-7.5 mm, forewing 6.8-7.2 mm, antennae 7.5-8.4 mm, cerci 6.0-6.5 mm.

Leptoperla alata, sp.n.

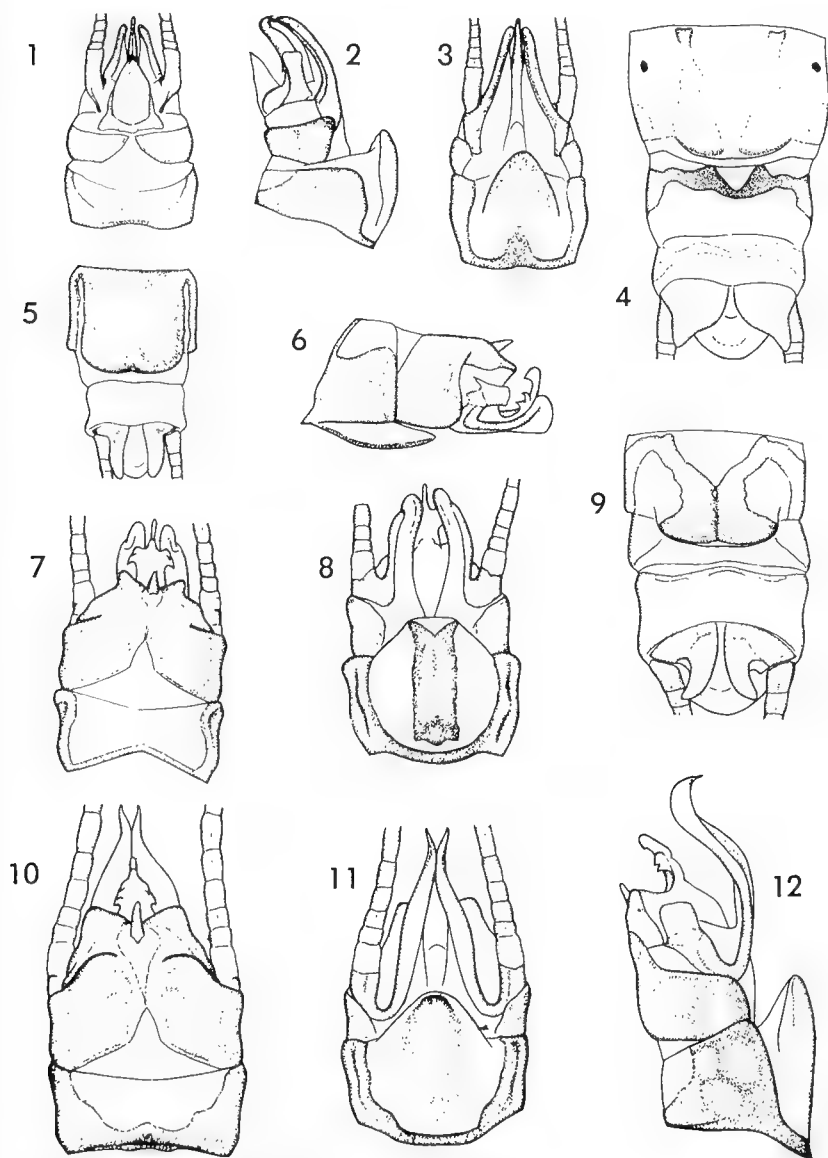
(Figs 6-9)

Types. QUEENSLAND: Holotype ♂ (T.8596) and 2 paratype ♂, Mt Spec, via Paluma, 21.iv.1968, G. Monteith (holotype in QM, paratypes in UQ); 1 paratype ♀, 2 mi. W. of Paluma, 28.iv.1969, I. F. B. Common and M. S. Upton (ANIC).

The males (young specimens preserved in alcohol) have head and thorax yellowish brown, femora and metatibia brownish yellow, darkened basally and apically, pro- and meso-tibia, and all tarsi and claws brown, transparent wings and a pale yellowish abdomen, while the single female (pinned) is much darker and has grey wings dotted whitish on distal crossveins of forewing. Male genitalia (Figs 6-8): Lateral sclerites of tergite X subtriangular, directed laterally; posterior sclerite a slim short straight cone. Epiproct with two large teeth on lateral lobe and a long, narrow hook-shaped tip bearing two extremely closely set teeth. Paraprocts short; apex wide, flat, rounded. Subgenital plate oval, median sclerotization swallow-tailed apically. Female genitalia (Fig. 9): Subgenital plate produced onto sternite IX, wide with slightly convex hind margin; sclerotization forming a roughly X-shaped pattern. Paraprocts with short narrow, slightly pointed inner lobe. Hindmargin of tergite X not angulated.

Measurements: Body ♂ 8.0-8.5 mm, ♀ 9.0 mm; forewing ♂ 7.5-8.0 mm, ♀ 9.5 mm; antennae ♂ 9.0-9.8 mm, ♀ 11.0 mm; cerci ♂ 6.5-7.0 mm, ♀ at least 6.2 mm (broken).

Diagnostic characters are the long narrow hook-shaped tip of the epiproct and the apically much widened paraprocts of the male and the



Figs 1-12. (1-4) *Dinotoperla hybrida* sp.n., 1, ♂ genitalia, dorsal view; 2, ♂ genitalia, lateral view; 3, ♂ genitalia, ventral view; 4, ♀ genitalia, ventral view. (5) *Kirrama abalos* Theischinger, ♀ genitalia, ventral view. (6-9) *Leptoperla alata* sp.n., 6, ♂ genitalia, lateral view; 7, ♂ genitalia, dorsal view; 8, ♂ genitalia, ventral view; 9, ♀ genitalia, ventral view. (10-12) *Leptoperla dahmsi* sp.n., 10, ♂ genitalia, dorsal view; 11, ♂ genitalia, ventral view; 12, ♂ genitalia, lateral view.

X-shaped sclerotization on the subgenital plate of the female. For affinities see under *L. rotunda* sp.n., below.

Leptoperla dahmsi, sp.n.

(Figs 10-13)

Types. QUEENSLAND: Holotype ♂ (T.8597) and 2 paratypes (1 ♂, 1 ♀), Fraser Island, Central Stn, 14-15.x.1978, G. B. Monteith, 2 paratypes (1 ♂, 1 ♀) Cooloola, Camp Milo, 3-13.iii.1970 and 1 paratype ♀, same locality, 17-28.viii.1979, E. Dahms (all QM).

Head and thorax brown. Femora yellowish grey with black apex, pro- and meta-tibia yellowish grey with brownish black base and apex, mesotibia and all tarsi and claws greyish black. Wings suffused largely with greyish brown, white patches on distal crossveins of forewing. Abdomen greyish yellow. Male genitalia (Figs 10-12): Lateral sclerites of tergite X subtriangular, posterior sclerite a finger-like process. Epiproct rather narrow with 2-3 teeth on each lateral lobe and narrow tip bearing two closely set teeth. Paraprocts long and slender, apical half bent dorsad, apex downcurved and pointed. Subgenital plate oval, narrow. Female genitalia (Fig. 13): Subgenital plate produced onto sternite IX, wide; a broad almost rectangular sclerotized bar with a very dark mark in basal half, each side and some distance from midline. Paraprocts with long narrow almost pointed inner lobe. Hind margin of tergite X rounded.

Measurements: Body ♂ 8.0-9.0 mm, ♀ 9.5-10.0 mm; forewing ♂ 8.8-9.8 mm, ♀ 10.0-10.5 mm; antennae ♂ 10.0-12.0 mm, ♀ 12.0-13.0 mm; cerci ♂ 9.0-10.5 mm, ♀ 10.0-11.0 mm.

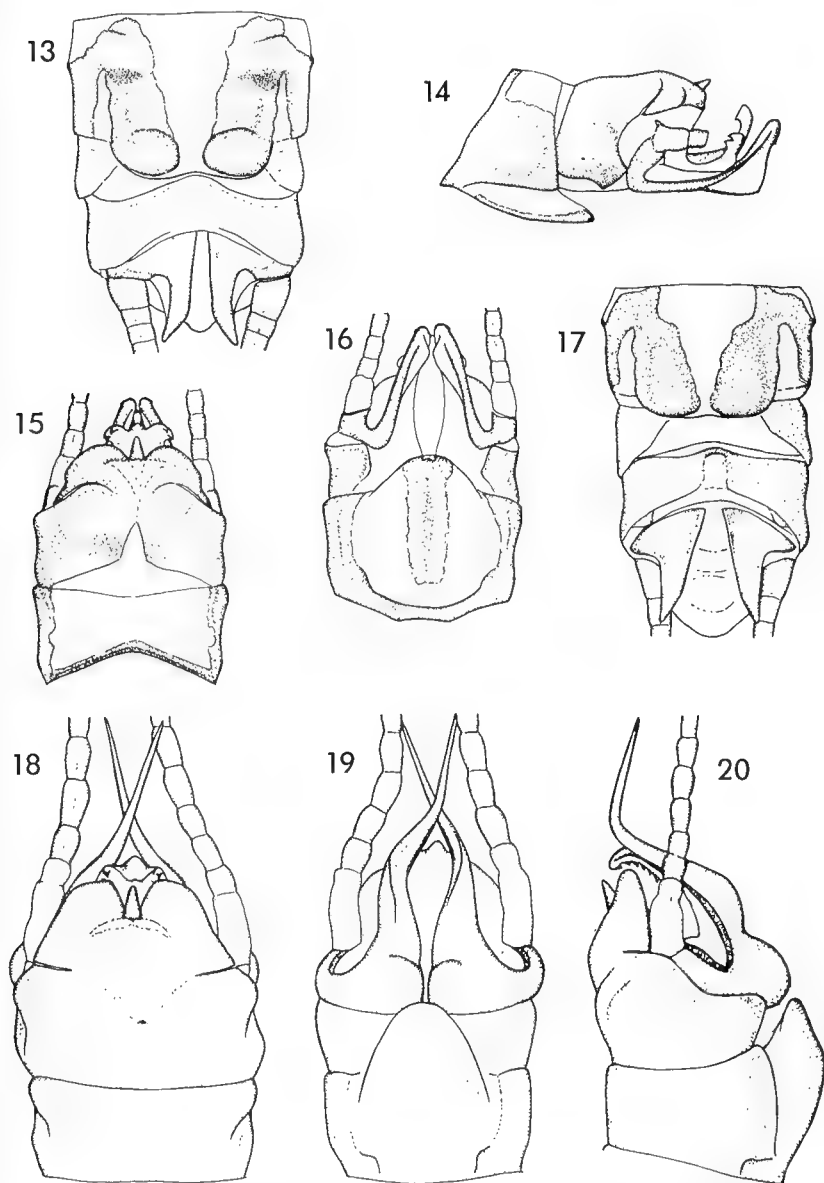
Diagnostic characters are the narrow pointed paraprocts of the male and the widely distant sclerotization on the subgenital plate of the female. For affinities see under *L. rotunda* sp.n., below.

Leptoperla rotunda, sp.n.

(Figs 14-17)

Types. QUEENSLAND: Holotype ♂ (T.8595) and 42 paratypes (33 ♂, 9 ♀), Bellenden Ker Range, Cable Tower 3, 1054 m, 25-31.x.1981, 5 paratypes (3 ♂, 2 ♀), Bellenden Ker Range, Summit TV Stn, 1560 m, 1-7.xi.1981, 1 paratype ♂, same locality, 25-31.x.1981, 2 paratype ♀, Bellenden Ker Range, 0.5 km S. of Cable Tower 7, 500 m, 17-31.x.1981, 5 paratypes (4 ♂, 1 ♀), Mt Bartle Frere, 0.5 km N. of South Peak, 1500 m, 6-8.xi.1981, and 1 paratype ♂, Mt Bartle Frere, NW/Centre Peak ridge, 1400-1500 m, all EARTH-WATCH/QM (QM).

Head and thorax greyish brown. Pro- and meso-femur and metatibia largely yellowish grey, distinctively darkened at base and apex; meta-femur grey with yellowish apex; pro- and meso-tibia and all tarsi and claws greyish black. Wings largely suffused with grey, white patches on distal crossveins of forewing. Abdomen pale yellowish grey. Male genitalia (Figs 14-16): Lateral sclerites of tergite X evenly rounded, posterior sclerite a straight short cone. Epiproct with narrow tip bearing two closely set teeth and with two teeth on each lateral lobe. Paraprocts narrow at base, with subtriangular ventral keel



Figs 13-20. (13) *Leptoperla dahmsi* sp.n., ♀ genitalia, ventral view. (14-17) *Leptoperla rotunda* sp.n., 14, ♂ genitalia, lateral view; 15, ♂ genitalia, dorsal view; 16, ♂ genitalia, ventral view; 17, ♀ genitalia, ventral view. (18-20) *Leptoperla rubiconis* sp.n., ♂ genitalia: 18, dorsal view; 19, ventral view; 20, lateral view.

in posterior half and small subapical ventral tooth. Subgenital plate broadly oval with dark median bar. Female genitalia (Fig. 17): Subgenital plate wide, produced onto sternite IX, a light subtriangular area between the two narrow trapezoid-shaped sclerotized dark bars. Paraprocts with narrow almost pointed inner lobe. Posterior margin of tergite X evenly rounded.

Measurements: Body ♂ 7.8-9.2 mm, ♀ 9.0-10.5 mm; forewing ♂ 7.5-9.2 mm, ♀ 9.0-10.0 mm; antennae ♂ 8.0-9.5 mm, ♀ 8.5-10.0 mm; cerci ♂ 6.5-7.5 mm, ♀ 7.0-8.0 mm.

Diagnostic characters are the rounded lateral sclerites of tergite X and the toothed paraprocts of the male. *L. rotunda* sp.n., *L. alata* sp.n. and *L. dahmsi* sp.n., together with *L. varia* Kimmins from Tasmania, *L. smithersi* Theischinger from north-eastern New South Wales, and *L. magnicauda* Theischinger and *L. uptoni* Theischinger, both from north-eastern Queensland, are considered a monophyletic group within *Leptoperla*.

Leptoperla rubiconis, sp.n.

(Figs 18-20)

Type. VICTORIA: Holotype ♂, Victoria, Rubicon, 29.iii.1957, A. Neboiss (NMV).

The single available specimen is very young: head, thorax and legs appear pale yellowish brown, the abdomen pale yellow, the wings transparent. Genitalia (Figs 18-20): Lateral sclerites of tergite X rounded, posterior sclerite straight, short, conical. Epiproct broad, subtriangular, armed with row of small dorsal teeth along lateral margins, slightly keeled ventrally, tip slightly bilobed, upturned. Paraprocts narrowing from wide base, widening again and finally tapering to form a long very slender sinuous wing-like structure. Subgenital plate oval.

Measurements: Body 7.0 mm, forewing 9.7 mm, antennae at least 6.3 mm (broken), cerci at least 4.2 mm (broken).

The extremely slender paraprocts are diagnostic for the species. *L. nevoissi* McLellan and *L. primitiva* McLellan, both hitherto known from Victoria only (McLellan 1971), are apparently the closest relatives.

Acknowledgements

For the opportunity to study material in their care I am very grateful to Miss J. C. Cardale (Canberra), Miss M. A. Schneider and Dr G. B. Monteith (Brisbane) and Dr A. Neboiss (Melbourne).

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A guide to the



BEETLES OF SOUTH-EASTERN AUSTRALIA

by

BARRY P. MOORE

B.Sc., Ph.D., D.Phil.

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5

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Subfamily TRECHINAE: small litter-dwelling or streamside species, readily recognised by the circular furrows that completely surround the eyes; most are not likely to interest the general student but the group is noteworthy because some of the Tasmanian species are blind and live in caves. I have recently revised the subfamily (Moore 1972).

Subfamily PTEROSTICHINAE: medium sized to very large, mostly flightless species, with prominent, secateur-like mandibles. These are the dominant carabids of the coastal wet forests from Mt Gambier (S.A.) to the tip of Cape York (N. Qld) and the student will soon become familiar with their general appearance, although this is difficult to describe. *Notonomus* is the largest genus, with over a hundred species, of which about a half occur in our area; many of these have a quite restricted range. *N. triplogenioides* Chaud. (24-28 mm) (Fig. 72) is a fine bronze species of the Illawarra rain forests and *N. aeneomicans* Chaud. (21-26 mm), black with bright brassy margins, occurs on Barrington Tops; these (and most other) species have the upper surface of the tarsi smooth and shiny but in *N. eques* Cast., of the Illawarra, and its close relatives further south, the tarsi are covered with minute grooves. *N. philippi* Newm. (18-21 mm), elytra scarcely striate, black with bronze reflections, is common about Melbourne in open country, an unusual habitat for the genus. Most local species are covered by Sloane's revision (1913).

Species of *Castelnaudia*, *Trichosternus*, *Nurus* and *Cratoferonia* occur in wet forests northwards from the Illawarra; they are large and heavy, flightless beetles, many of them with metallic tints. *Castelnaudia cyanea* Cast. (28-34 mm) (Fig. 73) is of a lovely and silky purplish-blue and ranges from the Royal National Park, south of Sydney to the Comboyne Plateau; *Cratoferonia regalis* Cast. (32-36 mm) (Fig. 70) is another fine purplish species with about the same range but here, the elytral odd intervals carry rows of small setae and the mandibles are shorter; north of the Comboyne it is replaced by a close relative, the bronze-black *C. phylarchus* Sl. *Nurus latipennis* Sl. (26-33 mm) (Fig. 69) is a very robust species from the New England Tablelands.

Sarticus is an important genus of flightless species that occur in open habitats; *S. cyaneocinctus* Chaud. (17-21 mm) (Fig. 60), shining black with bright purplish-blue margins and with a distinct ridge on each elytron, near the shoulder, is the finest and is now very widespread, probably having been favoured by clearing of the natural bush. All species likely to be encountered may be recognised to genus by the orbicular prothorax, without obvious hind-angles.

Hyperion schroetteri Schreib. (Fig. 66), though rather variable in size, can attain a length of 63 mm, to be our largest carabid; it is mainly a tableland and Riverina species that feeds on chafer grubs in large, hollow eucalypts. In the early days of railway building timber getters found these in some numbers, when cutting up the big Red River gums for sleepers but

nowadays they are rather hard to come by, although occasionally they fly to light. The related genus *Catadromus* also includes large, winged species; all are shining black with bright, golden-green margins. *C. laçordairei* Boisd. (28-37 mm) (Fig. 68), with the bright elytral margins continuous from base to apex and *C. australis* Cast. (38-47 mm) (Fig. 67), the bright margins divided lengthwise by a narrow black band, occur together over much of our area and are very common along the Murray River; they are reported to feed upon small frogs but the larvae are unknown.

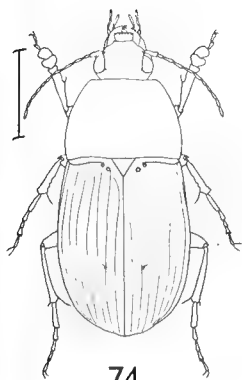
Students wishing to identify all the local genera of this important subfamily should consult my paper (Moore 1965).

Subfamily HARPALINAE: small to medium sized, mostly winged species, with short stout appendages and mandibles and with only one bristle (seta) beside each eye (most carabids have two). These are mostly unattractive species that are difficult to identify; many are very common, even in suburban gardens, and some are known to consume seeds and other vegetable matter. *Gnathaphanus pulcher* Dej. (14-19 mm) (Fig. 61), metallic green with reddish tints, is one of the most handsome and is quite common in coastal N.S.W. and Queensland.

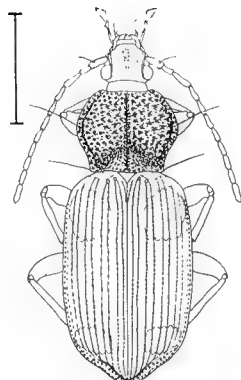
Subfamily CALLISTINAE: medium sized, winged species, the elytra pubescent (at least at sides), giving a velvet-like sheen, usually with metallic tints; only one seta beside each eye. These handsome beetles, which are better known under the name Chlaeniinae, are best developed in the tropics of the northern hemisphere and our few species are evidently derived from there by southward migration in comparatively recent times. *Hololeius nitidulus* Dej. (10-12 mm), shining bronze with bright green margins and yellow legs, is rare about Sydney but ranges northwards as far as India and several essentially Oriental species of the related genus *Chlaenius* occur in Queensland. *Chlaenius darlingensis* Cast. (13-15 mm) (Fig. 62), metallic green with elytral margins and legs pale yellow, is common beside creeks throughout our area but the broader *C. australis* Dej. (15-17 mm), head and thorax greenish-bronze, elytra brownish-black, legs black, prefers drier habitats and often flies to lights. The larva of *C. darlingensis* occurs in the same situations as the adult; it is a lithe and diurnal creature with exceptionally long urogomphi, conspicuously tipped with white and carried vertically over the back, rather than in the usual trailing position.

Subfamily OODINAE: medium sized, winged species, closely allied to the preceding but not pubescent; body of characteristic oval form. Some

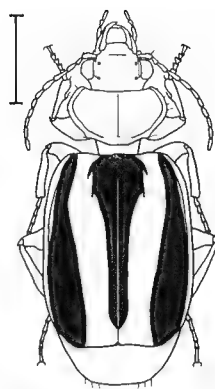
Figs 74-83. Carabidae. (74) *Coptocarpus australis* Dej.; (75) *Craspedophorus australis* Dej.; (76) *Philophloeus eucalypti* Germ.; (77) *Demetrida vittata* Dej.; (78) *Anomotarus crudelis* Newm.; (79) *Drypta australis* Dej.; (80) *Helluo costatus* Bon.; (81) *Eudalia macleayi* Bates; (82) *Sphallomorpha nitiduloides* Guer.; (83) *S. colymbetoides* Westw.



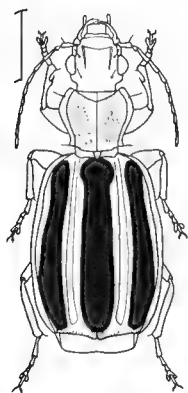
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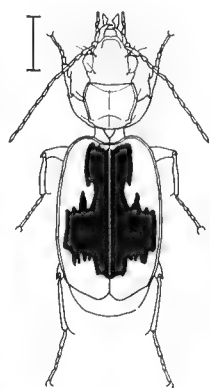
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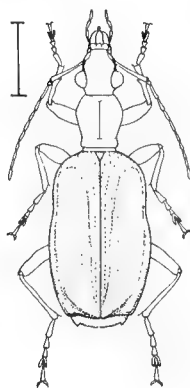
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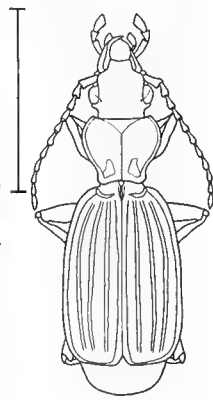
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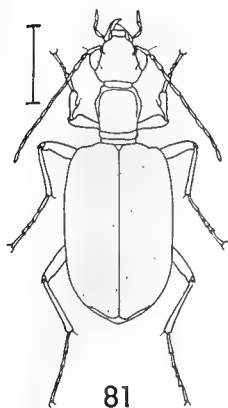
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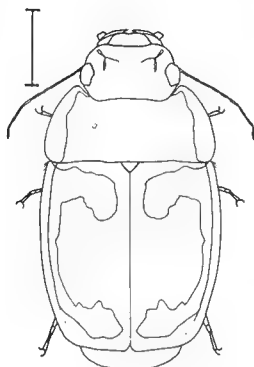
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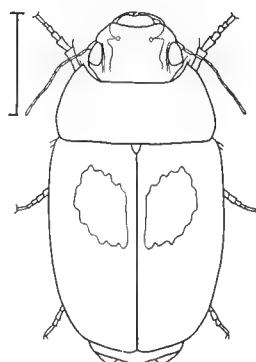
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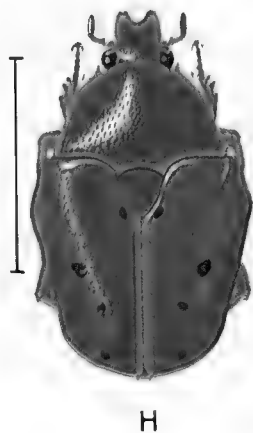
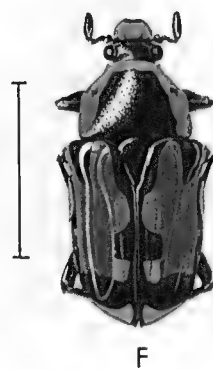
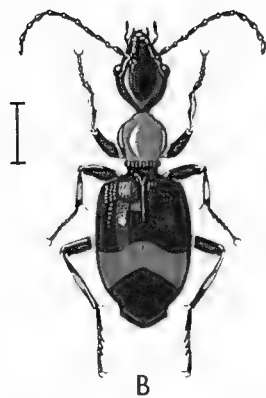
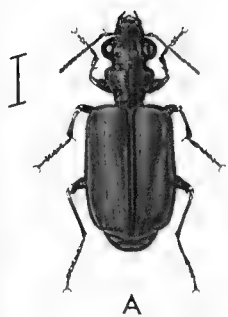
northern species are fine metallic beetles that come to light; the commonest with us are *Oodes modestus* Chaud. (8-11 mm), dull metallic bronze, and *Coptocarpus australis* Dej. (10-12 mm) (Fig. 74), entirely black; they are found in damp places.

Subfamily PANAGAEINAE: medium sized to rather large, coarsely sculptured and pubescent species; head very small, with prominent eyes; palpi securiform (hatchet-shaped); hindbody convex. These beetles are very readily recognised to group but the species are often poorly differentiated; some of the tropical ones are fully winged but those from the south-eastern States are all flightless members of the one genus, *Craspedophorus*. *C. australis* Dej. (*mastersi* Sl.) (12-14 mm) (Fig. 75) is largely coal-black but each elytron bears two conspicuous orange-red spots; it occurs during the cooler months in dry sclerophyll woodland, often in quite large groups, and is the species common about Sydney. *C. australasiae* Chaud. (10.5-12 mm) has larger, more reddish elytral spots and is found in the mallee districts of western Victoria and South Australia. Diverse populations occur on the eastern tablelands but their taxonomy has not yet been clarified.

Subfamily LEBIINAE: small to medium sized, mostly winged species; elytra truncate, leaving the last abdominal segment exposed above. These are mostly lightly built, plant frequenting beetles that, in the southern States, are commonest under bark of standing eucalypts. Many have yellow-striped elytra. The chief genera are *Demetrida* (*Xanthophoea*), rather elongate beetles, variously patterned, penultimate segment in all tarsi bilobed; *Philophloeus* broad, flat, pubescent species (6-13 mm), elytra mostly with a single pale yellow stripe on each (Fig. 76), tarsi simple; *Agonochila* similar in build to *Philophloeus* but mostly much smaller (5-7 mm), elytra usually with two pale wavy bands or spots; *Trigonothops*, similar in pattern to *Agonochila* but more elongate and not pubescent. *Demetrida brachinodera* Chaud. (12-13 mm), entirely pale straw-yellow, is the finest species but it is rather scarce; *D. grandis* Dej. (13-14 mm) and *D. vittata* Dej. (8-10 mm) (Fig. 77) have similar elytral markings in black and pale yellow, the latter species being very widespread. Species of the other genera are very numerous and difficult to identify.

Species of *Anomotarus* are unusual within this subfamily in being ground dwellers; *A. illawarrae* MacL. (6-7 mm), head, legs and underside black, thorax and elytra with a velvety bronze sheen, is diurnal and is often seen on pathways, running with a characteristic darting gait; *A. crudelis* Newm. (6-8 mm) (Fig. 78), pale yellow and black, often flies to lights.

Plate II. (A) *Scopodes splendens* Mre (Carabidae); (B) *Myrmecodemus riverinae* Sl. (Carabidae); (C) *Saprinus cyaneus* F. (Histeridae). (D-I) Scarabaeidae, Cetoniinae: (D) *Polystigma punctatum* Don.; (E) *Chlorobapta frontalis* Don.; (F) *Chlorobapta besti* Westw.; (G) *Diaphonia dorsalis* Don.; (H) *Schizorrhina atropunctata* Kirby; (I) *Trichaulax philipsi* Schreib. var. *macleayi* Kraatz.



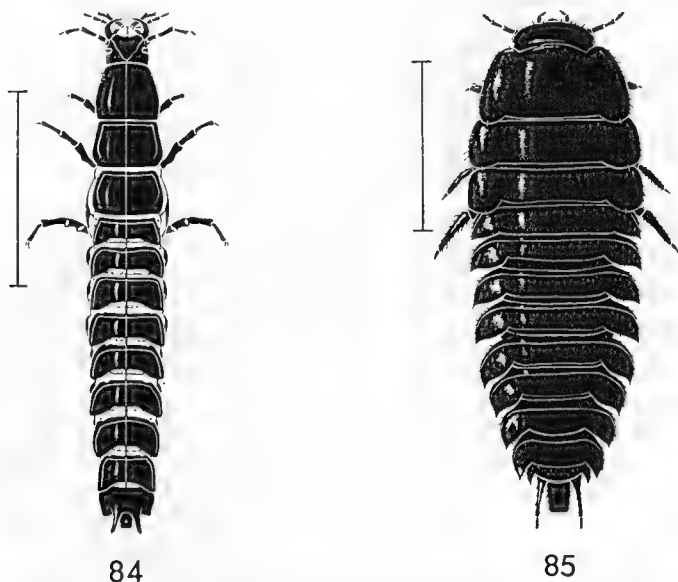
Subfamily DRYPTINAE: small species; foreparts very elongate; basal segment of antennae very long; elytra truncate. A numerically small but worldwide group, the species all with a similar and very characteristic build. *Drypta australis* Dej. (8-10 mm) (Fig. 79), head, thorax and elytral fasciae red, centre and margins of elytra bluish black, is the only local species; it lives in long grass or rushes in damp places and often comes to lights at night.

Subfamily HELLUONINAE: medium sized to large, elongate flattish and rather heavily built, black or metallic species; eyes prominent; labrum very large; elytra truncate. Most of the species are winged but there are several heavy, flightless ones in Western Australia. *Helluo costatus* Bon. (20-27 mm) (Fig. 80), dark brown, coarsely punctured and pubescent, elytra with marked costae (ridges), is a ground dweller and is common from Melbourne to southern Queensland, in dry forests. *Aenigma iris* Newm. (17-21 mm), brilliant purple, and *Dicranoglossus resplendens* Cast. (11-13 mm), purplish-blue, are prizes to be had occasionally from Sydney northwards, under eucalypt bark; they run rapidly when disturbed.

Subfamily PENTAGONICINAE: small, active, mostly diurnal beetles; eyes large; elytra truncate as in Lebiinae. Species of *Scopodes* resemble miniature Tiger beetles but the elytra are without pale marks. These attractive little beetles are often seen in open places, darting over sun-lit ground in a characteristic staccato gait; their large eyes are obviously adapted for hunting by sight. *S. sigillatus* Germ. (3.5-4 mm), dull bronze, legs yellowish, and *S. boops* Blbn (4-4.5 mm), entirely coal-black, are the commonest and *S. splendens* Mre (5-5.5 mm) (Pl. II, A) is the prettiest. The last mentioned appears to be confined to the Snowy Mountains, where my wife and I discovered it some years ago. *S. tasmanicus* Bates (6-7 mm), silky black, occurs in wetter forests in Tasmania and Victoria and is most often seen on fallen logs, whereas the blue-black *S. simplex* Blbn (5-6.5 mm) is confined to the highest peaks of the Australian Alps. Species of *Pentagonica*, the only other genus, are litter dwellers and are much less often seen.

Subfamily ODACANTHINAE: small species; head with prominent eyes and a pronounced neck; prothorax very narrow or globular; elytra truncate as in Lebiinae. Mainly tropical, these delicate beetles are mostly associated with aquatic vegetation and the elongate forms hunt and hide in the stems of hollow reeds. The broader *Eudalia* species occur in gravel beside running water: *E. macleayi* Bates (9-10 mm) (Fig. 81), dull brownish-bronze, with yellow legs, is widespread; *E. castelnaui* Sl. (10-12 mm), entirely black, is confined to the mountains. *Myrmecodemus riverinae* Sl. (6.5-7.5 mm) (Pl. II, B) is a pretty antlike species found in *Juncus* swamps beside the Murray and other larger inland rivers.

Subfamily BRACHININAE: the well known Bombardier beetles. These beetles share with the Paussinae one of the most highly developed systems of chemical defence evolved by insects. Hydroquinone (quinol) and hydrogen peroxide are secreted in special cells and stored, as an aqueous mixture, in large abdominal reservoirs. When disturbed the beetles release some of this mixture into paired reaction chambers, where contact with the enzyme peroxidase causes an explosive reaction to take place, with release of hot vapour containing steam, quinones and oxygen. The release is through special



Figs 84-85. Exceptionally sclerotised (armoured) beetle larvae. (84) *Pamborus macleayi* Cast. (Carabidae); (85) *Ptomaphila lachrymosa* Schreib. (Silphidae).

nozzles on each side of the anus and can be directed towards any would-be predator. Since these beetles usually occur in groups, they produce a veritable salvo when molested.

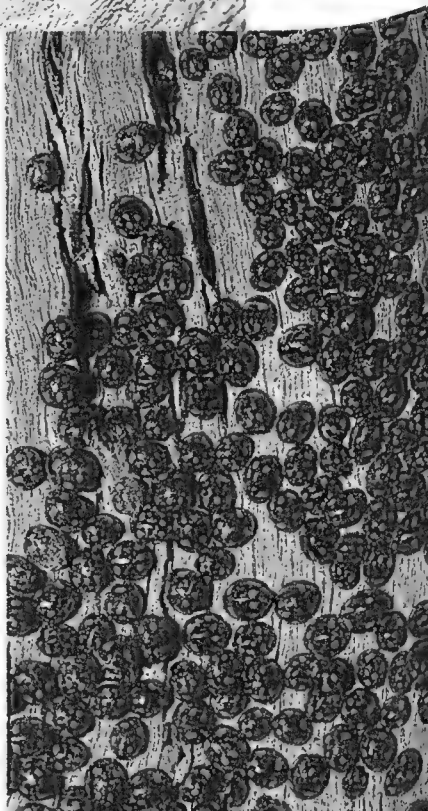
Bombardier beetles are plentiful in the northern hemisphere but we have only one widespread species, namely *Pheropsophus verticalis* Dej. (13-19 mm) (Fig. 53), easily recognised from its black-and-yellow pattern and its behaviour. This species occurs in damp places, especially the margins of billabongs, and is abundant along the Murray River; its larva has not yet



A

Plate III. (A) *Tritocosmia roei* Saunders (Cerambycidae); (B) *Paraprius australasiae* Boisd. (Coccinellidae), hibernating cluster, under bark.

Plate IV. (A) *Stigmodera jacquinoti* Boisd.; (B) *Stigmodera macularia* Don. (Buprestidae).



B.



been reported but from what is known about exotic species, it may be presumed to be a parasitoid, possibly of grasshopper or mole-cricket egg caches.

Subfamily PSEUDOMORPHINAE: very aberrant carabids; body smooth, compact, oval or cylindrical; legs and antennae short, retractile. Although a few species are known from other regions, Australia is the headquarters of this curious group, all members of which are most probably closely associated with ants. The adult beetles move very fast but because of their short legs and closeness to the substrate, they appear to glide rather than run across the surface.

One of our commonest species is *Sphallomorpha colymbetoides* Westw. (12-14 mm) (Fig. 83), a dark brown, oval beetle with a large, yellowish-brown spot on each elytron. Larvae of this and related species are found around the nests of Meat ants (*Iridomyrmex purpureus* Smith), where they live in vertical burrows, very much after the manner of larval Tiger beetles, and prey upon the ants as they pass by. An ant is seized by a leg and quickly paralysed, apparently by injection of a toxin secreted by the very swollen larval palpi; its juices are then sucked out, leaving a somewhat shrunken but otherwise intact shell. The larva moults twice as it continues to grow and when full-sized, seals its burrow and retires to a pupation chamber. The adult beetle emerges from the pupa in about two weeks but remains in its cell for some time before coming to the surface to begin the life-cycle again. *Sphallomorpha nitiduloides* Guér. (9-11 mm) (Fig. 82), head black, thorax largely yellow, elytra brown with pale whitish marginal crescents, has identical habits. Species of *Silphomorpha* have a similar form but lack all pale markings; they are difficult to identify and nothing is known about their life-histories. *Adelotopus* and *Cainogenion* include small, cylindrical species that seem to be associated with smaller, tree-dwelling ants.

Family DYTISCIDAE

(Predacious Water beetles)

Tarsal formula: 5-5-5

Antennae: filiform

Small to rather large, smooth, oval species adapted for life in water; head deeply set in prothorax; hind tarsi flattened and fringed with long hairs, to form efficient oars; front tarsi of males expanded, with suction discs beneath. Larvae campodeiform, with strongly tapered hind segments; legs 5-segmented.

Dytiscid beetles have a very characteristic general appearance and are not likely to be confused with any others except the Hydrophilidae, but their long, filiform (thread-like) antennae will distinguish them from the latter. When swimming, dytiscids stroke both hind legs simultaneously, whereas hydrophilids do so alternately.

Adult dytiscids fly readily, mostly after sunset, and pitch directly into water, which they recognise from its reflections, but they are sometimes deceived by glass and other man-made shiny surfaces. When under water, they breathe through abdominal spiracles from an air reserve trapped under the elytra, and they need to return to the surface periodically to renew the supply. They are voracious predators upon a wide variety of aquatic animals, ranging from other insects and their larvae to tadpoles and small fish.

The larvae are equally voracious but, unlike the adults, they do not chew their prey: their long, sickle-like jaws (Fig. 16) carry a narrow channel along which digestive juices are pumped into their victims, which are then sucked dry by a reversal of the process. These larvae breathe through a narrow syphon, formed by the greatly elongated eighth abdominal segment and, like the adults, they need to come to the water's surface periodically for fresh supplies of air. When full grown, the larvae leave the water to pupate in an earthen cell.

All four subfamilies currently recognised are represented in this country but the species of Laccophilinae and Hydroporinae, though numerous, are mostly small and unlikely to interest the general coleopterist. The Colymbetinae and Dytiscinae, which include the larger species, may be distinguished as follows:

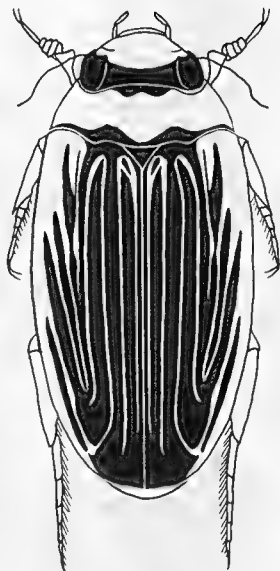
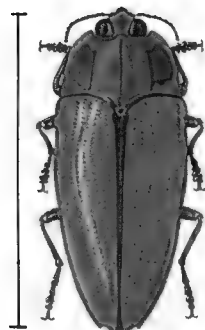
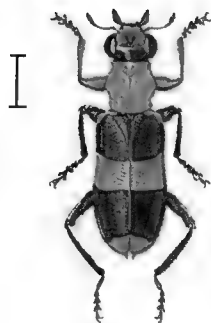


Fig. 86

Lancetes lanceolatus Clark



A



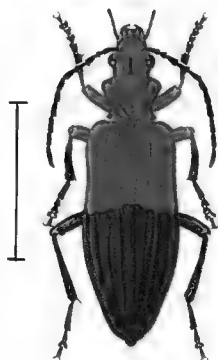
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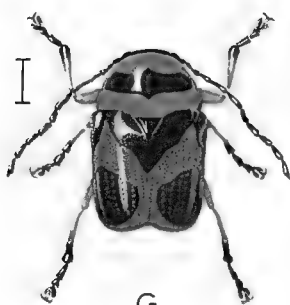
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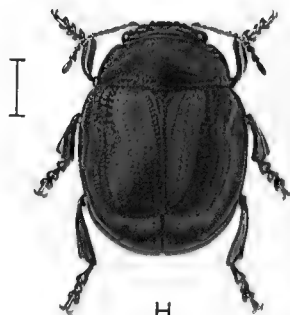
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F



G



H

Inner border of eye above antenna excised by an intrusion of the frons. Colymbetinae
 Inner border of eye above antenna entire Dytiscinae

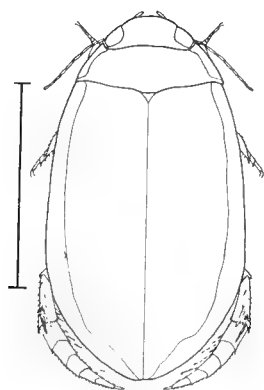
Rhantus suturalis MacI. (*pulverosus* Steph.) (12-13 mm) (Colymbetinae) is one of our commonest species and it also has a very wide distribution overseas. Typically, it is yellowish in ground colour, with a conspicuous oval spot on the pronotum and numerous fine markings on the elytra brownish-black, but all-dark specimens also occur. The related *Lancetes lanceolatus* Clark (11-12 mm) (Fig. 86) may be recognised by its finely and neatly black-striped elytra and its rather more elongate form, with truncate elytral apices.

The Dytiscinae include our largest species, namely, *Cybister tripunctatus* Ol. (22-30 mm) (Fig. 87) and *Homoeodytes scutellaris* Germ. (25-28 mm) (Fig. 88); both are olive-black, margined with dull yellow, but the pronotal pale margins are straight-sided in the former, angled in the latter. Technically, these two genera may be separated by the claws of the hind tarsi: single in *Cybister*, twin but unequal (Fig. 11) in *Homoeodytes*.

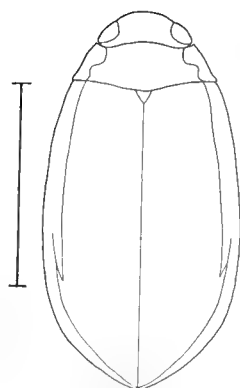
Smaller species of this subfamily include *Eretes australis* Er. (12-16 mm) (Fig. 89), of a rather pale brownish yellow with narrow, black, transverse marks, and with exceptionally long and slender tarsal claws. This is probably the commonest water beetle of the outback, in temporary pools, man-made dams, etc. *Hydaticus parallelus* Clark (13-15 mm), dark red-brown to black, with broad, reddish-yellow borders to head and pronotum, may be recognised locally by its rather parallel sided form; it is essentially a species of the coastal regions and the one southern representative of a largely tropical genus. *Spencerhydrus latecinctus* Sharp (13-17 mm) (Fig. 90), sides of pronotum and elytra broadly margined in yellow, is a robust species that appears to be confined to Victoria.

The Australian dytiscids have recently been revised by Watts (1978).

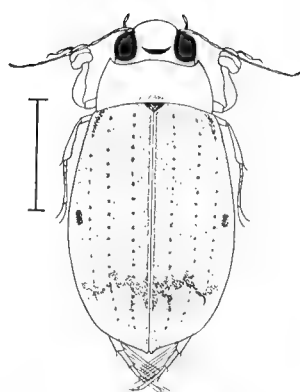
Plate V. (A) *Calodema regalis* Lap. and Gory (Buprestidae); (B) *Lemidia spinipennis* Lea (Cleridae); (C) *Phlogistus eximius* White (Cleridae); (D) *Dicranolaius villosus* Lea (Melyridae); (E) *Agasma semicrudum* Newm. (Oedemeridae); (F) *Lemodes splendens* Lea (Anthicidae); (G) *Cryptocephalus speciosus* Guer. (Chrysomelidae); (H) *Augomela hypochalcea* Germ. (Chrysomelidae).



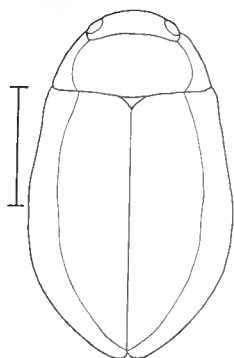
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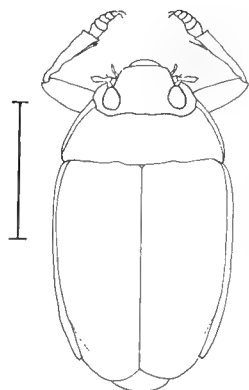
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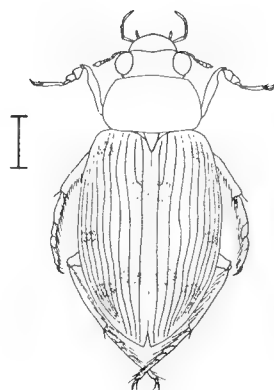
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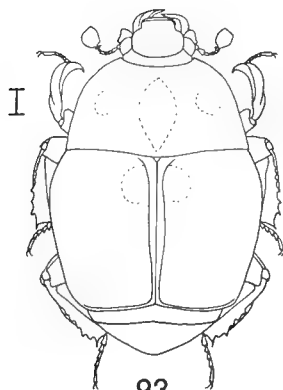
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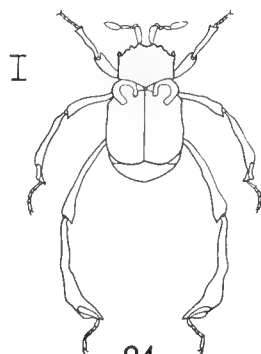
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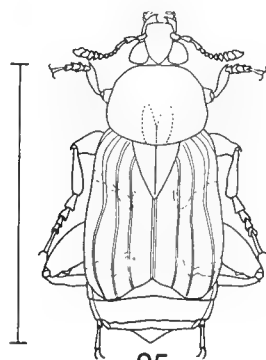
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95

Family GYRINIDAE (Whirligig Beetles)

Tarsal formula: 5-5*-5*

Antennae: very short, stout

Small to medium sized, oval species adapted for life on the water's surface. Front legs long, raptorial, middle and hind legs very short, flattened, to form fast-moving paddles; eyes completely divided by margins of head, to permit simultaneous vision above and below the water's surface. Larvae campodeiform, very slender, with numerous lateral abdominal gills; legs 5-segmented.

These streamlined beetles are so characteristic in build and habits that they are unlikely to be confused with any others; they are highly gregarious and are most often observed in large groups, resting or swimming leisurely on the surface of fresh standing or gently flowing water. The short antennae rest in contact with the water and are used to detect ripples caused by drowning insects and other small creatures that form the prey. When disturbed, these beetles gyrate rapidly and if pressed further, dive and swim below the surface, to reappear at a safe distance. They also fly readily on warm evenings and are frequently attracted to lights.

The eggs are generally deposited upon the stems of emergent aquatic plants and the resulting larvae are fully adapted from the outset to life in water; they are delicate creatures, provided with a row of long, feather-like gills on each side of the abdomen, and they swim by means of an undulatory motion of the whole body. The mouthparts are of the biting type and the prey consists of mayfly and stonefly larvae and other small aquatic animals. Pupation takes place in an earthen cell above high water mark.

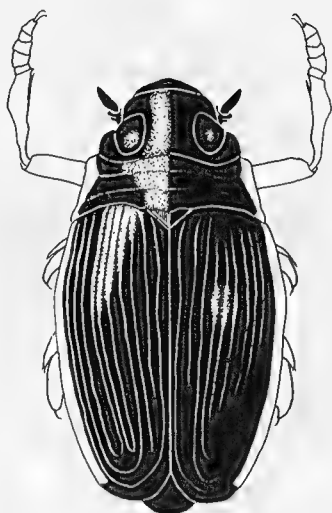


Fig. 96

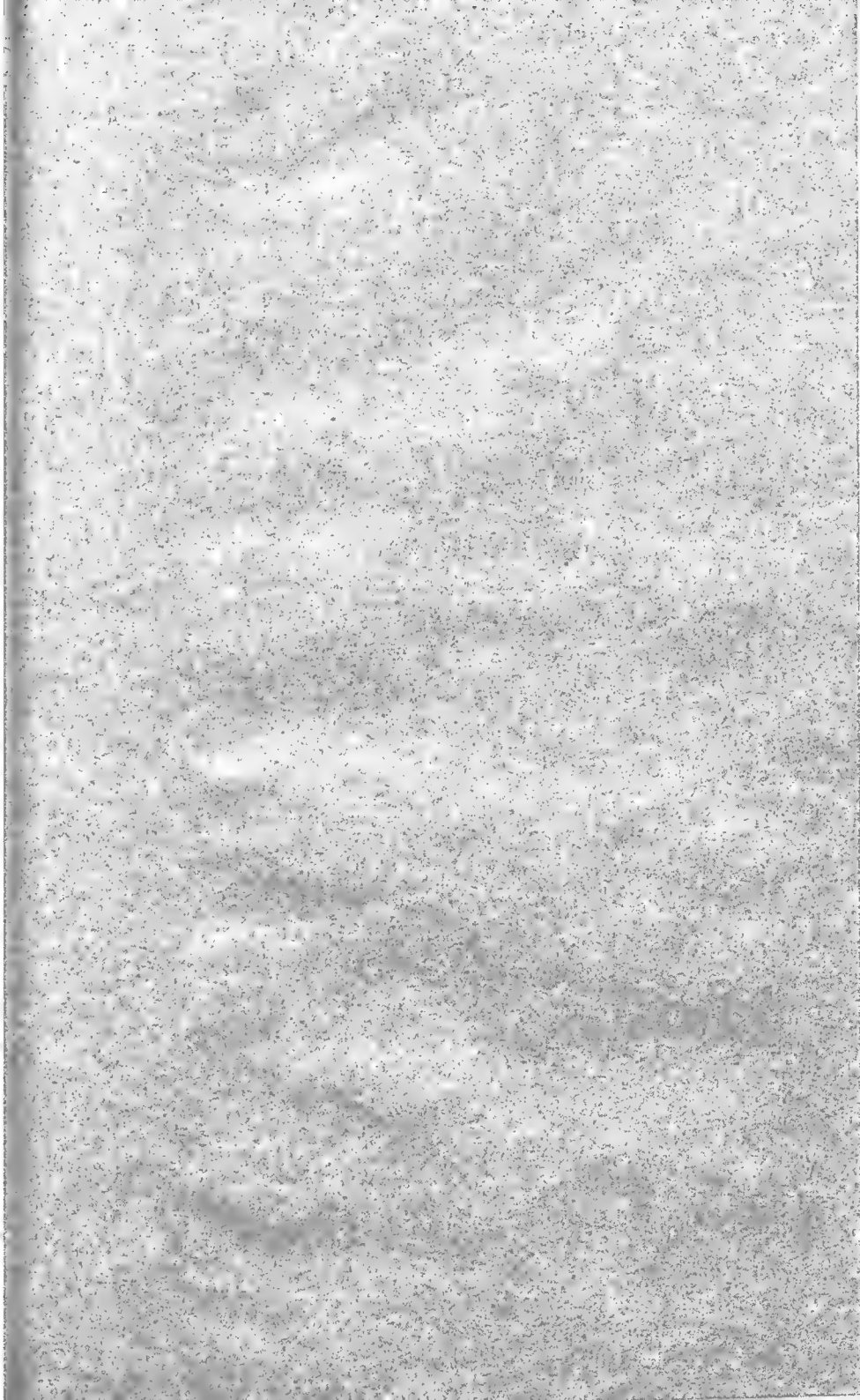
Aulonogyrus strigosus F.

Figs 87-95. (87-90) Dytiscidae: (87) *Cybister tripunctatus* Ol.; (88) *Homoeodytes scutellaris* Germ.; (89) *Eretes australis* Er.; (90) *Spencerhydrus latecinctus* Sharp; (91) *Macrogyrus striolatus* Guér. (Gyrinidae); (92) *Berosus australasiae* Muls. (Hydrophilidae); (93) *Saprinodes falcifer* Lewis (Histeridae); (94) *Chlamydopsis longipes* Lea (Histeridae); (95) *Diamesus osculans* Vig. (Silphidae).

Our largest species belong to the genus *Macrogyrus*, with *striolatus* Guér. (15-18 mm) (Fig. 91), black with metallic tints, as the giant of the group. This beetle occurs widely in New South Wales and southern Queensland. *M. oblongus* Boisd. (12.5-14 mm), olive-green, elytra with metallic green striae, and *M. rivularis* Clark (12-16 mm), brown, with coppery striae, are also fine, widespread species; they are mostly found on the quieter pools beside clear running waters.

Among the smaller species, *Dineutus australis* F. (6.5-9 mm), bronze-black, sides with blue or green reflections, may be recognised by the absence of a visible scutellum; it occurs in all States. *Aulonogyrus strigosus* F. (5.5-6.5 mm) (Fig. 96) has the prothorax and elytra conspicuously margined with yellow and is also widespread; it prefers rather swiftly flowing waters. *Gyrinus convexiusculus* Macl. (3.5-4.8 mm), shining black, bronzed laterally, is the smallest species of the fauna and it occurs in all the eastern States.

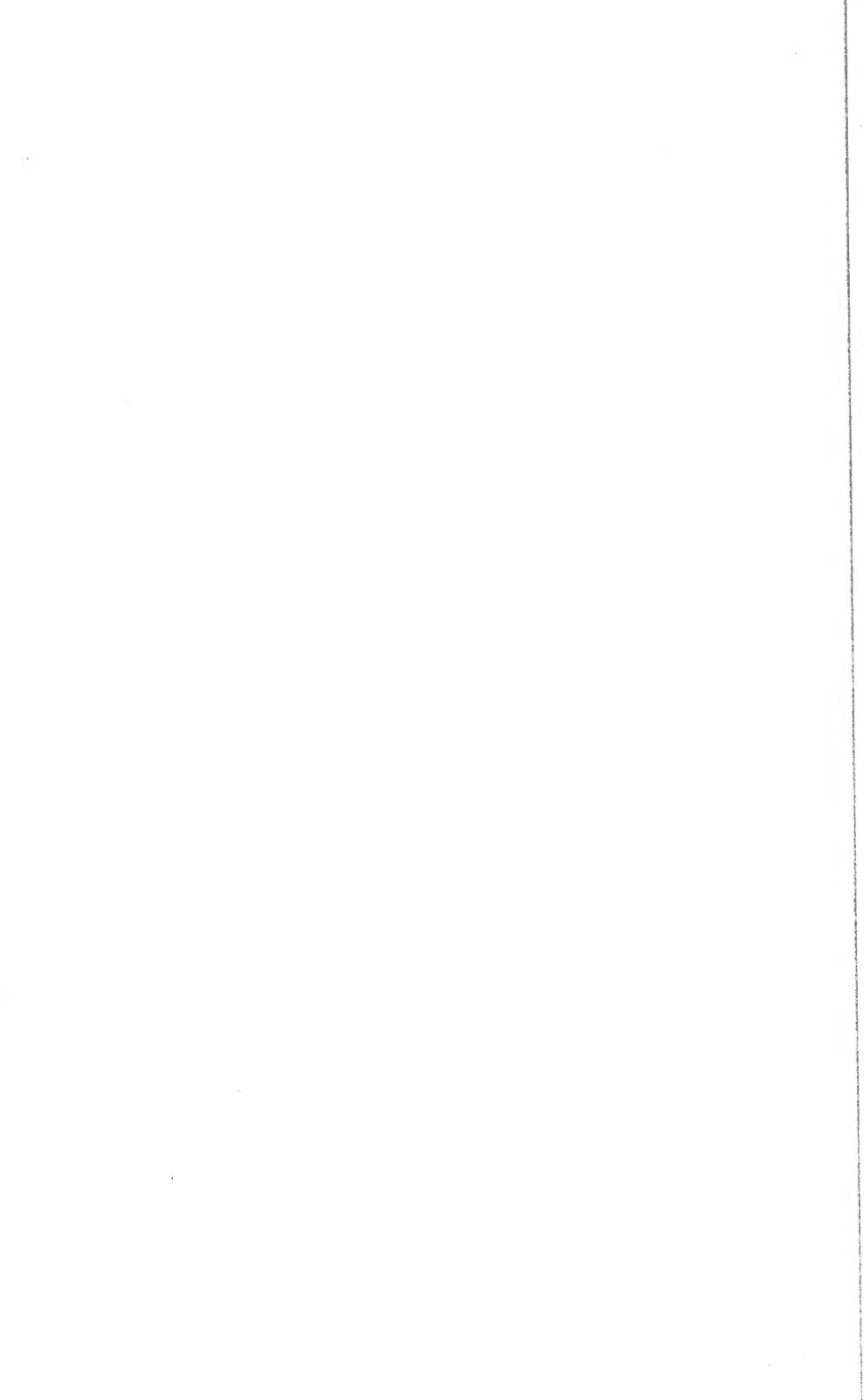
The Australian Gyrinidae have been revised by Ochs (1949, 1956).



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